

**A revision of the genus *Pacifigorgia*
(Coelenterata: Octocorallia: Gorgoniidae)**

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Abstract.—The genus *Pacifigorgia* is revised based on original type-specimens and new specimens recently collected. In addition to *P. irene* Bayer and *P. bayeri* Breedy, which are the only well defined, seventeen other species are recognized as valid (*P. adamsii*, *P. agassizii*, *P. arenata*, *P. cribrum*, *P. darwinii*, *P. douglasii*, *P. elegans*, *P. englemanni*, *P. exilis*, *P. eximia*, *P. gracilis*, *P. media*, *P. pulchra*, *P. rutila*, *P. stenobrochis*, and *P. tabogae*). The species are described and illustrated in detail with photomicrographs and scanning electron micrographs of the sclerites. Lectotypes are proposed for eight species.

Octocorals of the families Gorgoniidae and Plexauridae represent the most abundant and spectacular fauna of the shallow tropical American waters (Bayer 1961). Comprehensive taxonomic research has been undertaken on the Caribbean and the western Atlantic octocorals (Bayer 1959, 1961), improving the knowledge and providing a means of identification of these organisms. In contrast, very few studies have been carried out on the eastern Pacific octocorallian fauna.

Six genera of Plexauridae, four of Gorgoniidae (Verrill 1868a, 1869a, 1870; Hickson 1928, Bayer 1958), and one of Ellisellidae (Bayer & Deichmann 1960) have been recognized in the eastern Pacific region which extends from southern California to Perú, including the Galápagos Islands. The first descriptions of these organisms appeared in scattered publications in the 19th century (Valenciennes 1846, Milne Edwards & Haime 1857, Horn 1860; Verrill 1863, 1864, 1866, 1868a, 1868b, 1868c, 1869a, 1869b, 1870). Verrill (1868c, 1869a, 1870) included these species in his paper "Notes on Radiata", and added several new ones. In the 20th century, Kükenthal (1924)

published a massive revision of the order Gorgonacea and included the species previously described for the eastern Pacific. Although he provided a key to the eastern Pacific fauna, he did not make any new contribution to this group. Hickson (1928) described 27 species from the Pacific coast of Panamá and the Galápagos Islands. Stiasny (1941, 1943) also wrote about the octocorals of Panamá and reviewed the species described previously by Hickson (1928). Nevertheless, the lack of good specimen and sclerite illustrations in these publications has made it difficult to recognize genera and species. Even though the drawings by Verrill (1868c, 1869a, 1870, 1912) are beautiful and accurate, they are not totally adequate for identification purposes, since only few types of sclerites or any are presented. Furthermore, the establishment and description of species without a holotype, in many cases resulted in inconsistencies and has led to taxonomic confusion. This was evident in the studies of von Prah et al. (1986) and Sinsal-Duarte (1991) in Colombia and Baja California, México, respectively, where the identification of gorgoniids was not sufficiently clear and hence

somewhat doubtful. Bayer (1981) placed the octocorallian fauna of the eastern Pacific in the "poorly known" category of knowledge. According to him, it is in serious need of revision, and in many cases the designation of lectotypes, in order to clarify the identity of these species is necessary (pers. comm. 1999).

Pacifigorgia is one of the most abundant genera of the family Gorgoniidae inhabiting the eastern Pacific area (one species has been recorded from the western Atlantic). Species of this genus are commonly known as sea fans. They are mainly found in zones of strong currents, swell and breaking surf. In general, the fan-like colonies orient perpendicular to the direction of water motion as in most of the gorgonians (Wainwright & Dillon 1969, Grigg 1972, Kinzie 1973, Levesee 1976, Weinbauer & Velimirov 1995). They are always attached to rocky bottoms, shells, and small rock fragments, or they can be found on coarse sand (pers. obv.).

Sea fans from the eastern Pacific were included by early taxonomists in the genera: *Gorgonia* Linnaeus, 1758; *Rhipidogorgia* Valenciennes, 1855; *Leptogorgia* Milne Edwards & Haime, 1857; and *Litigorgia* Verrill, 1868c. These authors failed to designate type species for these genera or to accept previous designations (Bayer 1951). According to Bayer (1951), *Gorgonia* as established by Linnaeus, was a heterogeneous collection of genera (gorgoniids, antipatharians, a plexaurid, and a muriceid). Valenciennes (1855) proposed the genus *Rhipidogorgia* for fan-like octocoral species with anastomosing branches, but he did not designate a type species. Milne Edwards & Haime (1857) established *Leptogorgia* for several species with slender, non-anastomosing branches, and failed to indicate a type species. Verrill (1868a), who established *Litigorgia* based on the forms of the sclerites, included species with both reticulated and non-reticulated colonies, but also did not designate a type species. However, later in that same year, he designated

Leptogorgia florum Verrill as the type of *Litigorgia*, *G. flabellum* Linnaeus as the type of *Gorgonia*, and *G. viminalis* Pallas (sensu Milne Edwards & Haime 1857) as the type of *Leptogorgia*, and also made *Litigorgia* and *Leptogorgia* synonymous. In 1918, Bielschowsky designated *G. flabellum* as the type of *Rhipidogorgia*, overlooking the earlier designation of Verrill (1868c) for *Gorgonia*, thus making both genera synonymous.

In a later study, Bayer (1951) acknowledged *Rhipidogorgia* as a synonym of *Gorgonia* and established the genus *Pacifigorgia* for reticulate gorgoniids lacking scaphoid sclerites.

Sixteen species have been previously assumed to the genus *Pacifigorgia*. Several of these species were described from only one whole specimen or from a substantial fragment. Many colonies were not illustrated and only one or two kinds of sclerites were considered for identification purposes. With the exception of *Pacifigorgia irene* Bayer, 1951, and recently *Pacifigorgia bayeri* Breedy, 2001, that have holotypes and well-illustrated descriptions, the other descriptions failed to provide details of growth form, color, and sclerite variation, which are essential characteristics for the identification. Apart from *P. bayeri* this fauna was described 50 to 150 years ago and, for many of them, their taxonomic status is not clear.

The present research provides a redescription of each species, when needed, based on original type-material, all the other material available in several museums, and fresh specimens collected recently by the authors. The species are illustrated with photographs of the colonies, and photomicrographs and scanning electron microscope-micrographs of their sclerites. Lectotypes have been designated where appropriate.

This study represents the first contribution in a series that attempts to reevaluate the genera of Gorgonacea reported for the

shallow eastern Pacific waters. In this first paper we revise the genus *Pacifigorgia*.

Abbreviations

BM: The Natural History Museum, London, UK; CASIZ: California Academy of Science, Invertebrate Zoology, San Francisco, USA; CIMAR: Centro de Investigación en Ciencias del Mar y Limnología, Universidad de Costa Rica, Costa Rica; CME: Centro de Microscopia Electrónica, Universidad de Costa Rica; ICZN: International Code of Zoological Nomenclature; MNHN: Muséum National d'Histoire Naturelle, Paris, France; MZC: Museum of Comparative Zoology, Harvard University, Cambridge, USA; SEM: Scanning Electron Microscopy; STRI: Smithsonian Tropical Research Institute, Panamá; UCR: Museo de Zoología, Escuela de Biología, Universidad de Costa Rica; USNM: National Museum of Natural History (former United States National Museum), Smithsonian Institution, Washington, D.C., USA; YPM: Yale Peabody Museum of Natural History, New Haven, USA.

Material and Methods

Type specimens and comparative reference material used in this study were acquired on loan from the BM, CASIZ, MCZ, MNHN, USNM, and YPM. Other material from the UCR and STRI collections was also examined. Except for the holotype of *Pacifigorgia darwinii*, which was preserved in ethanol, all the type specimens from available collections were dry colonies.

The specimens were processed following Bayer's (1961) methodology. Small fragments from the tips of the colonies were treated with sodium hypochlorite to dissociate sclerites from tissue. They were washed several times in distilled water, and finally in 100% ethanol, then air or oven dried. For permanent microscope slides of sclerites, Permout mounting medium was used. The only type material of *P. douglasii* and *P. tabogae* are microscope slides of

sclerites, from Sidney Hickson's personal 1928 collection, mounted with Canada balsam. A Nikon compound microscope with a Nikon NFX-35 camera was used to take the color photomicrographs. For SEM, the sclerites were attached to aluminium stubs by double stick carbon tape, and silver paint bridges between the tape and the stub, were made for better electronic conduction. The samples were coated with a 30–45 nm layer of platinum in an Eiko IB-5 or with 30 nm gold layer in an Eiko IB-3 Ion Coater, and observed and photographed under an N-SEM 2360 Hitachi scanning electron microscope using 10–12 kv acceleration voltage. The measurements of the sclerites were obtained from the pictures and directly from a light microscope using an optical micrometer. The length of the sclerites was measured from one tip to the other and the width was taken from the most distant points across the sclerite. The given ranges of sizes were based on the smallest and the largest measures of a specific kind of sclerite found. Dimensions of the polyps and thickness of the branches were made with vernier calipers using a dissection stereoscope. Size of the colonies was measured with a ruler, the height being the distance from the base of the holdfast to the most distal border of the fan, and the width being the distance between the most distant horizontal points crossing the fan. Identification and descriptions are based on the works by Horn (1860), Verrill (1863, 1864, 1866, 1868a, 1868b, 1869a, 1870, 1912), Kükenthal (1924), Bielschowsky (1919, 1929), Hickson (1928), Stiasny (1941, 1943, 1951), Studer (1891), Bayer (1951, 1961), Harden (1979), Prahl et al. (1986), Sinsel-Duarte (1991), and Breedy (2001). Earlier descriptions for each species are cited and a redescription is given using standard terminology (Bayer et al. 1983). Each species is illustrated with photographs: the whole holotype or lectotype colony, a close up, a micrograph of the sclerites for relative proportion and size observation, and SEM microphotographs of the sclerites for orna-

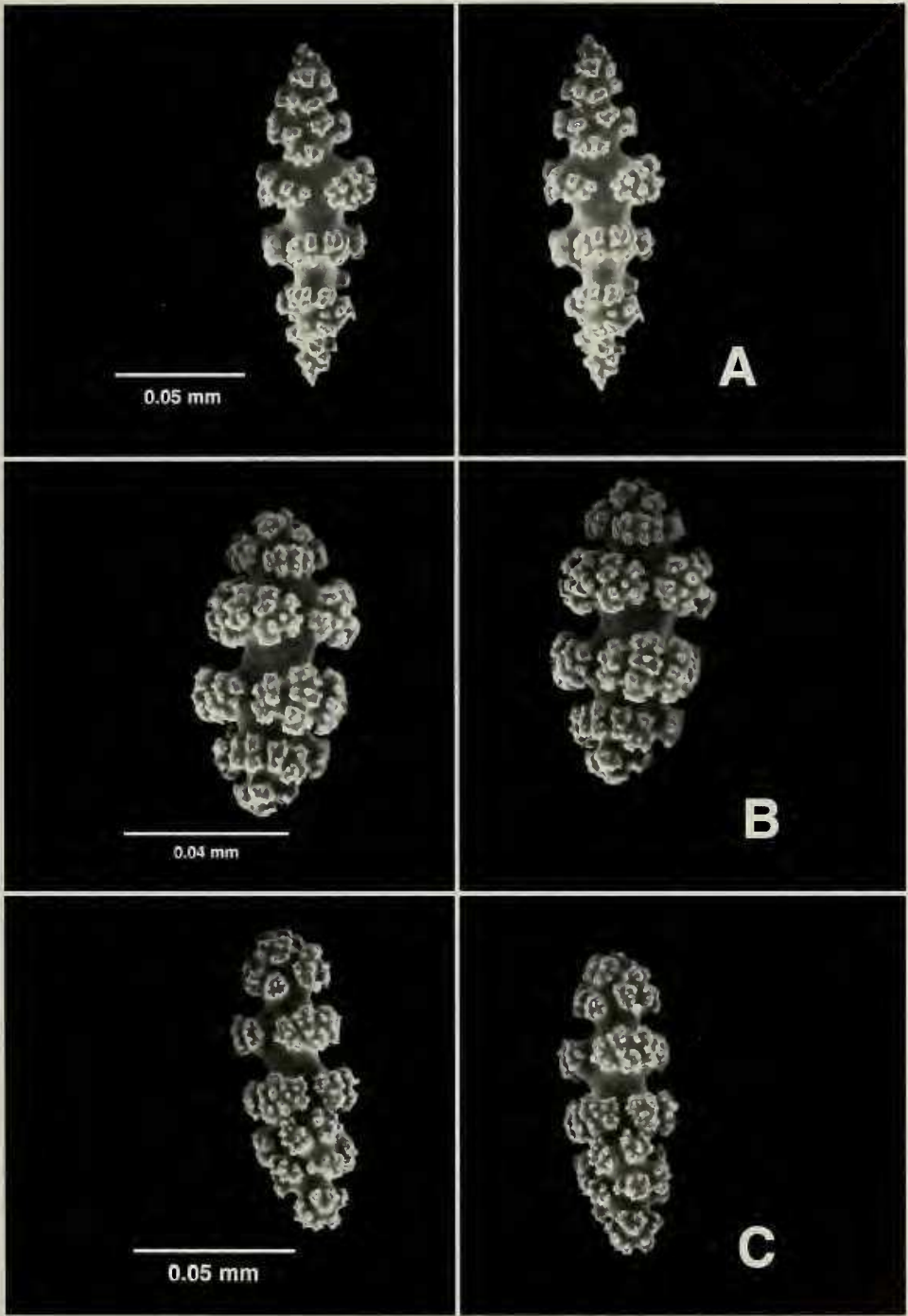


Fig. 1. Coenenchymal sclerites of *Pacifigorgia* (stereo view of SEM micrographs). A. Spindle with acute ends. B. Blunt spindle or elongated capstan. C. Dagger spindle.

Table 1.—Comparative features of the species of the gorgoniid genus *Pacificorgia*. The size of the sclerites is a range of the maximum length and width measured.

	Color of colony	Branches diameter (mm)	Network	Mesh (mm)	Midrib	Color of sclerites	Spindles (mm)	Blunt spindles (mm)	Anthocodial rods (mm)
<i>P. adamsii</i>	Purple/gold-ochre	0.5–0.08	fine-regular	square 1–2.5	absent	red/yellow/ colorless/ bi-colored	0.09–0.13 by 0.03–0.05	0.06–0.07 by 0.03–0.03	yellow/light orange 0.06–0.10 by 0.01–0.03
<i>P. agassizii</i>	Orange-yellow calyces	1–1.25	fine-regular	oblong/round 1–3	present	red/yellow/ colorless/ bi-colored	0.09–0.10 by 0.04–0.05	0.07–0.1 by 0.04–0.05	yellow 0.05–0.09 by 0.01–0.03
<i>P. arenata</i>	Reddish-yellow calyces	1–2.5	open-regular	square/polygonal 1–22	present	red/yellow/ bi-colored	0.09–0.10 by 0.04–0.05	0.07–0.08 by 0.03–0.04	pale yellow 0.05–0.10 by 0.01–0.02
<i>P. bayeri</i>	Deep yellow- dark purple	1–1.5	close-regular	round/oblong 2–5	absent	red/yellow	0.09–0.12 by 0.05–0.06	0.07–0.11 by 0.03–0.05	yellow/pink/red 0.05–0.10 by 0.02–0.04
<i>P. cribrum</i>	Reddish brown	0.5–1	fine-regular	square 0.75–2	absent	red/yellow/ bi-colored	0.09–0.13 by 0.03–0.04	0.08–0.09 by 0.03	yellow 0.05–0.09 by 0.01
<i>P. darwinii</i>	Purple/yellow ca- lyces	1.5–3	open-regular	oblong/polygonal 2–13 by 2–3	absent	purplish red	0.08–0.1 by 0.04	0.06–0.09 by 0.03–0.05	pale yellow 0.05–0.1 by 0.01–0.02
<i>P. elegans</i>	Red-purple	0.5–1.5	open-regular	oblong/polygonal 3–7 by 2–6	absent	purplish red/ yellow	0.08–0.1 by 0.03–0.04	0.06–0.09 by 0.03–0.04	pale yellow 0.06–0.08 by 0.01–0.09
<i>P. engelmanni</i>	Red-ochre	1.5–3.5	open/close regular	round/square 1–15 by 1–3	absent	red/yellow	absent	0.07–0.08 by 0.03–0.04	orange small
<i>P. exilis</i>	Red-orange	1–2.5	close-regular	square/oblong 0.5–3	present	red/yellow/ bi-colored	0.10–0.11 by 0.03–0.05	0.07–0.09 by 0.03–0.04	yellow 0.08–0.12 by 0.01–0.02
<i>P. eximia</i>	Deep red/dark orange	1.5	open-regular/ irregular	rectangular 1–30 by 2–3	absent	bright red	0.10–0.15 by 0.03–0.05	0.08–0.11 by 0.04–0.05	light yellow 0.07–0.10 by 0.01–0.02
<i>P. gracilis</i>	Deep red	0.5–0.7	Open-irregu- lar	square/oblong 10–20 by 2–7	Absent	red/yellow/ bi-colored	0.09–0.14 by 0.03–0.05	absent	red/orange 0.05–0.12 by 0.01–0.03
<i>P. irene</i>	Rusty purplish red	0.5–0.7	fine-regular	square 1–5 by 1–4	present	red/pale yel- low	0.09–0.11 by 0.02–0.04	0.05–0.09 by 0.02–0.04	colorless 0.05–0.09 by 0.02

Table 1.—Continued.

	Color of colony	Branches diameter (mm)	Network	Mesh (mm)	Midrib	Color of sclerites	Spindles (mm)	Blunt spindles (mm)	Anthocodial rods (mm)
<i>P. media</i>	Red/brown	1.2–2	open-regular	square 2–2.5	present	red/yellow	0.1–0.13 by 0.04–0.05	0.07–0.09 by 0.04–0.05	pale orange 0.07–0.11 by 0.01–0.03
<i>P. pulchra</i>	Red/orange	0.6–1	open-regular	angular/oblong 1–20 by 2–20	absent	red/yellow/ bi-colored	0.08–0.11 by 0.03–0.05	0.05–0.07 by 0.03–0.04	orange 0.07–0.14 by 0.02–0.03
<i>P. rutila</i>	Burned orange	1–1.5	fine-regular	round/oblong 0.25–1.5 by 1–2	absent	pink/light or- ange	0.09–0.14 by 0.03–0.05	0.08–0.10 by 0.030–0.04	pale orange 0.09–0.11 by 0.01–0.02
<i>P. stenobrochis</i>	Purple/Brown	2–5	open-regular	rectangular 10–35 by 1–4	Absent	pink/light yellow	0.10–0.12 by 0.04–0.04	0.08–0.09 by 0.042	Yellow 0.04–0.07 by 0.01–0.02

mentation and detail observation. Diagnoses and descriptions of the species of *Pacifigorgia* were mainly based on the specimens identified by Verrill deposited in the YPM, because it was that collection upon which he based his descriptions. In the case of *Pacifigorgia douglasii*, *Pacifigorgia englemanni* and *Pacifigorgia tabogae*, very little from the original specimens was ever found despite searches amongst the following octocoral collections: YPM (E. Lazo-Wasem, pers. comm. 1999); MCZ (A. Johnston, pers. comm. 1999); USNM (S. Cairns, pers. comm. 1999); National Museum of Natural History Naturalis, Leiden (L. van Ofwegen, pers. comm. 1999); Museo regionale di Scienze Naturali Zoologia, Torino (L. Levi, pers. comm. 1999); MNHN (M. J. d’Hondt, pers. comm. 2000); BM (S. Halsey, pers. comm. 2000); Manchester Museum, Manchester (H. McGhie, pers. comm. 2000); CASIZ (G. Williams, pers. comm. 2001) and the Academy of Natural Sciences, Philadelphia (E. Benamy, pers. comm. 2000). However, microscope slide preparations of the holotypes of *Pacifigorgia douglasii* and *Pacifigorgia tabogae* from the BM collections, were made available to us for this study.

Terminology

In this study, we followed the terminology proposed by Bayer, Grasshoff and Verveeldt (1983) for the description of the species. However, in some cases, the introduction of new terms or modifications of older ones applying to *Pacifigorgia*, were considered appropriate.

anthocodial rod: monoaxial sclerite somewhat flattened and smooth, with plain, serrated, lobed, scalloped, or dented margins or any combination of these forms (Fig. 3).

capstan: rod with two whorls of tubercles or warts, with a clear median space. In most of the cases, tubercles and warts are present at the ends of these sclerites and fuse at different levels to form terminal

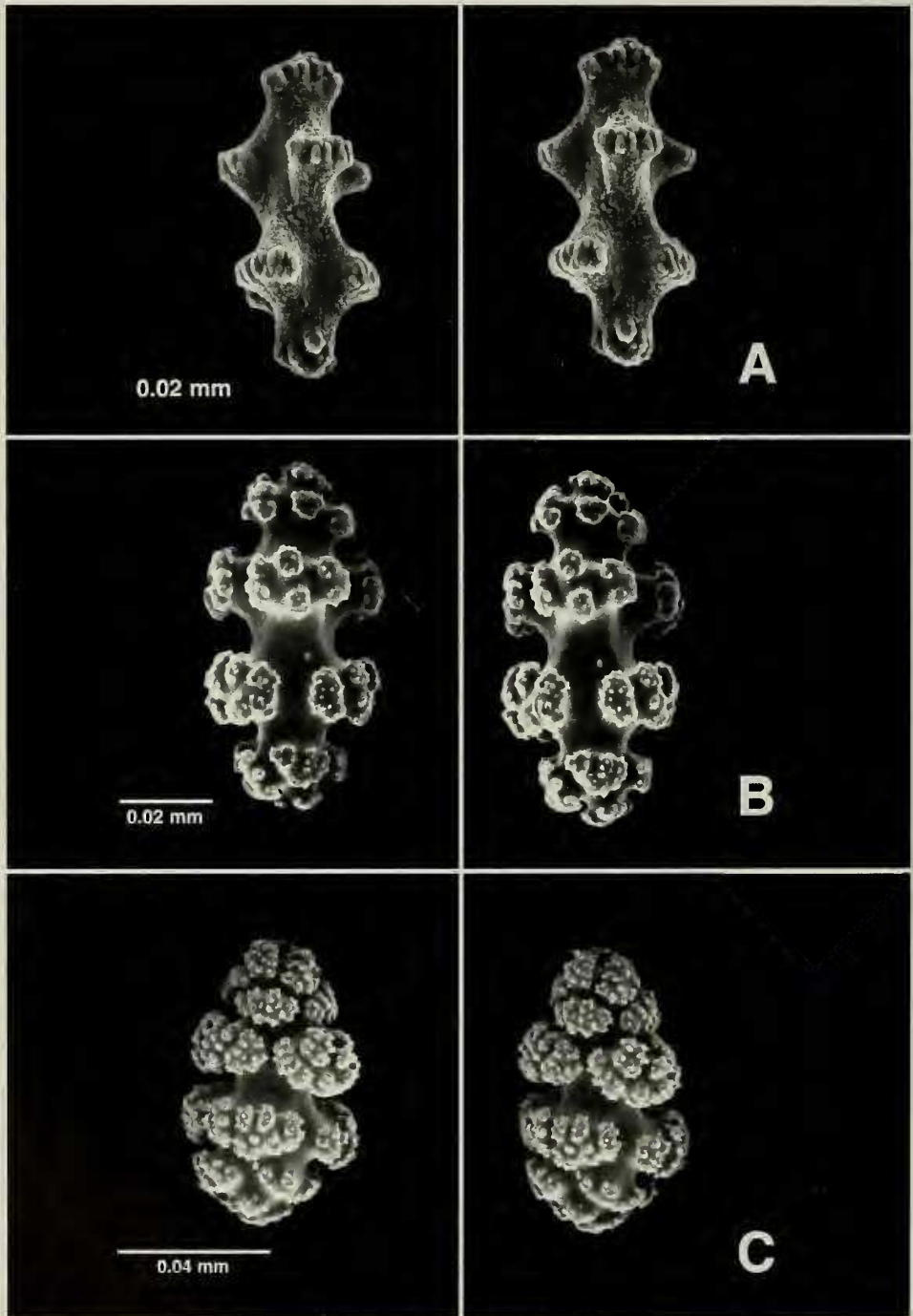


Fig. 2. Coenenchymal sclerites of *Pacifigorgia* (stereo view of SEM micrographs). A. Coenenchymal rod. B-C. Capstans.

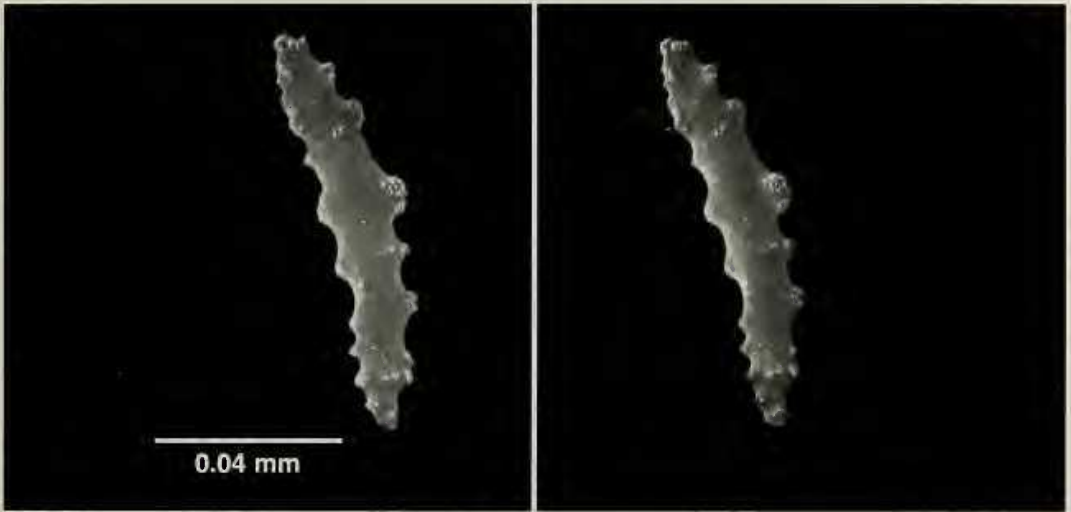


Fig. 3. Anthocodial rod of *Pacifigorgia* (stereo view of SEM-micrographs).

tufts. Six, seven and eight-radiate sclerites are kinds of capstans (Fig. 2B, C).
 coenenchymal rod: axis with flat conical and simple projections and with acute or blunt ends (Fig. 2A).
 dagger spindle: asymmetrical monoaxial sclerite with one end acute, and in some cases, very sharp, and with the other end blunt, with a warty terminal tuft and with at least a whorl of tubercles (Fig. 1C).
 end-branchlets: terminal, unanastomosed branches of a reticulate fan.
 free-twigs: short, unanastomosed branches projecting into the meshes of a reticulate fan.
 fans: erect leaf-like or blade-like structures, which form a colony.
 irregular network: reticulate structure resulting from incomplete anastomosis of branches.
 mesh: free space enclosed by anastomosed branches.
 midribs: thick branches subdividing and extending on the network of the fan, which vary in extension, thickness and shape.
 radiate: monoaxial sclerite radiating in one or several planes with less than eight tubercles (three to seven radiate sclerites).
 regular network: resulting from the com-

plete anastomosis of the branches in reticulate fans.
 spindle: sclerite with a straight or a slightly curved axis, with more than two whorls of tubercles or just sculptured with scattered, prominent warts, and with acute or blunt ends (Fig. 1A, B).

Morphology

The genus *Pacifigorgia* is characterized by anastomosing branches, which form networks. The network is the main difference between this genus and *Leptogorgia*, whereas previously some species of *Pacifigorgia* were included in the genus *Leptogorgia* (Verrill 1868c). The colonies may form single or compound fans. The diameter of the branches ranges from 0.05–0.07 mm to 2–5 mm. The branches anastomose to form regular or irregular reticulate fans, and in some species both forms are present in large colonies. In each species the mesh is very characteristic in size and shape. However, the mesh of secondary fans is commonly looser than that of the primary fan. Colonies are always attached to the substratum by a holdfast of diverse dimension and form. The colonies can be strengthened by midribs, which vary in

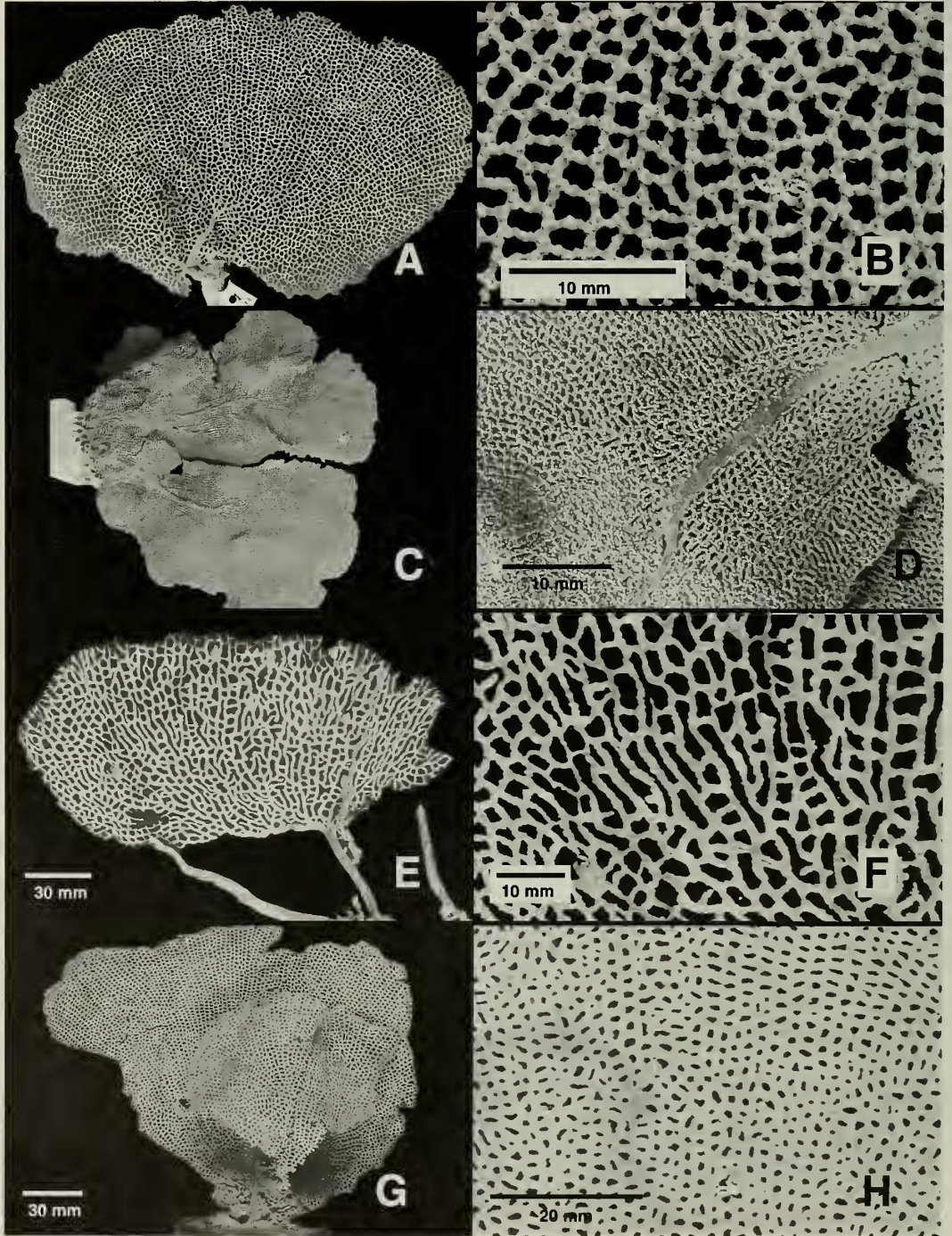


Fig. 4. A-B. *Pacifigorgia adamsii* (YPM 1173k). C-D. *Pacifigorgia agassizii* (YPM 956a). E-F *Pacifigorgia arenata* (MNHN). G-H. *Pacifigorgia cribrum* (MNHN). A, C, E, G. Entire colonies. B, D, F, H. Detail of branches.

thickness, ramification and extension. Some colonies, however, have no midribs whatsoever, which produces more flexible fans. Commonly, the calyces are not prominent, but in some species they form relatively large conical projections. Their arrangement and density around the branches is characteristic for each species; nevertheless, there is a general tendency to find more distant and dispersed calyces on the thicker branches, midribs and holdfasts.

The sclerites of the calyces and coenenchyme are basically of three kinds: capstans (Fig. 2B–C), rods (Fig. 2A, Fig. 3), and spindles (Fig. 1A–C). Some species bear rings of anthocodial sclerites, which consist of mostly longitudinally arranged rods below the base of the tentacles. For most of the species the arrangement of the anthocodial sclerites could not be determined because the specimens studied had been dry for so long. Tentacular sclerites are reported in a few species. The polyps withdraw completely into the calyces or the coenenchyme. The main types of sclerites are shown in Fig. 1A–C, Fig. 2A–C, and Fig. 3, which consist of SEM-micrographs mounted in stereo-pairs allowing 3D viewing of these structures. In contrast to many gorgonaceans, in *Pacifigorgia* (as in *Leptogorgia*), the coenenchyme is very thin. For this reason, differences in sclerite content in different tissue layers are very difficult to determine; nevertheless, expected variation is minimal (Grasshoff 1988). Species are identified by the combination of forms, colors, and sizes of sclerites in the samples; instead of individual specific types, or aggregations in coenenchymal layers. According to Grasshoff (1988), the “classical” method of presenting the sclerites of a species by separate drawings of their forms does not give the impression of the typical sclerite features.

The color in *Pacifigorgia*, as in *Leptogorgia* (Grasshoff 1988), plays an important role in taxonomy. According to Bayer (1961), the color of the colony in octocorals is dependent on the pigments in the scler-

ites, and when the organism is alive, its color depends also on symbiotic algae and pigments in the tissues. Consequently, a colony might change its color drastically if the polyps are expanded or contracted. The sclerites in *Pacifigorgia* are basically a combination of yellow, red and purple hues, or are colorless. The color is retained in dry or wet preserved specimens, although sometimes, the specimens turn the ethanol yellow.

Family Gorgoniidae Lamouroux, 1812

Genus *Pacifigorgia* Bayer, 1951

Rhipidigorgia (partial) Valenciennes, 1855: 13.—Milne Edwards & Haime, 1857: 173.—Horn, 1860:233.

Rhipidogorgia (partial).—Verrill, 1864: 32.—Duchassaing & Michelotti, 1864: 20.—Verrill, 1869:424.

Litigorgia (partial) + *Eugorgia* (partial) Verrill, 1868c:414.

Leptogorgia (partial) Verrill, 1869b:420.—Verrill, 1870:548.

Gorgonia.—Bielschowsky, 1918:32.—Kükenthal, 1924:338.—Bielschowsky, 1929:141.—Stiasny, 1941:268.—Stiasny, 1943:74.

Pacifigorgia Bayer, 1951:94.

Type species.—*Gorgonia stenobrochis* Valenciennes, 1846, by original designation (Bayer 1951:94).

Diagnosis.—According to Bayer (1951), colonies flabellate, branched in one or several parallel planes. Branches regularly anastomosed to form a network with a mesh of various dimensions. Calyces absent or raised only slightly above surface of coenenchyme. Coenenchymal sclerites basically of three kinds: long spindles with acute ends and several whorls of warts; long (up to 0.2 mm) or short (around 0.06 mm), blunt spindles with several whorls of warts; and capstans ornamented with different levels of complexity. Anthocodial sclerites are flattened rods with smooth, scalloped, indented or lobed margins.

Table 2.—Distribution of the gorgoniid genus *Pacifigorgia*, based on Valenciennes 1846–1855 (Val); Verrill 1868a–70 (V); Hickson 1928 (H); Bayer 1951 (Ba), 1961 (Bb); Breedy & Guzmán, pers. obs. (B&G).

	Baja California	Acapulco Mexico	Corinto Nicaragua	Costa Rica	Panama	Zorritos Peru	Galapagos Islands	Trinidad/ Brazil/ Venezuela	? Ze
<i>P. adamssii</i>			V	B&G	V, H, B&G	V			
<i>P. agassizii</i>	V	V			H				
<i>P. arenata</i>				B&G	B&G				Val
<i>P. bayeri</i>				B&G	B&G				Val
<i>P. cribrum</i>									
<i>P. darwini</i>						H			
<i>P. douglasii</i>						H			
<i>P. elegans</i>								Bb	
<i>P. engelmanni</i>		V							
<i>P. exilis</i>	V								
<i>P. eximia</i>				B&G	V, H				
<i>P. gracilis</i>	V				H				
<i>P. irene</i>				Ba, B&G	Ba, B&G				
<i>P. media</i>	V	V	V		H				
<i>P. pulchra</i>	V, H								
<i>P. rutila</i>	V	V	V	B&G	V, H, B&G	V			Val
<i>P. stenobrochis</i>					H				
<i>P. tabogae</i>									
Total	6	5	3	5	9	1	2	1	

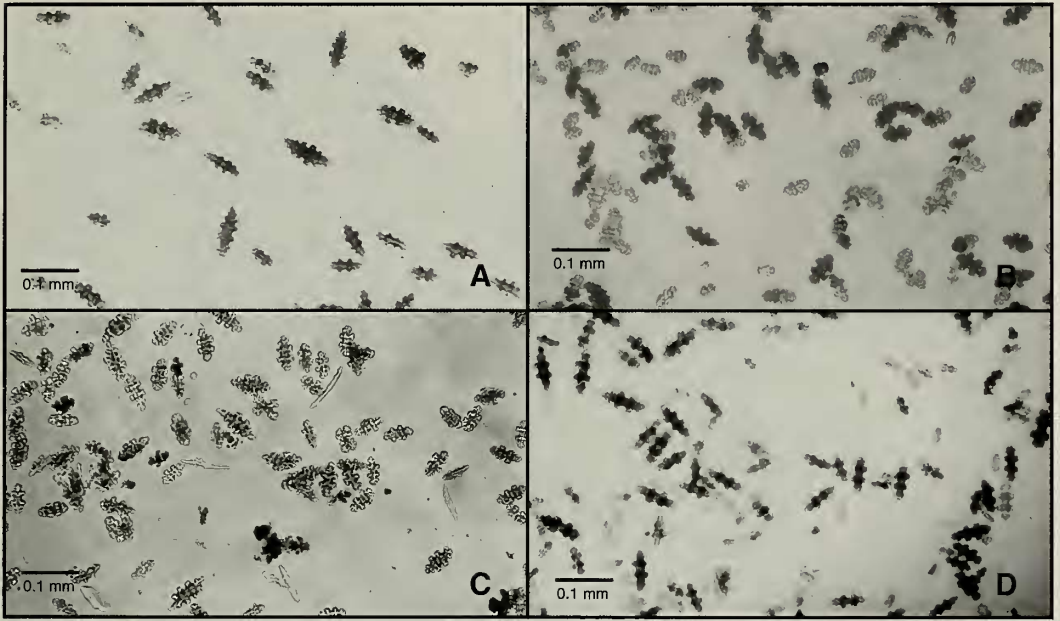


Fig. 5. A–D. Photomicrographs of sclerites. A. *Pacifigorgia adamsii* (YPM 1173k). B. *Pacifigorgia agassizii* (YPM 956a). C. *Pacifigorgia arenata* (MNHN). D. *Pacifigorgia cribrum* (MNHN).

Distribution.—Eastern Pacific, from southern California to Chile and the Galápagos Islands; Atlantic coast from Trinidad to Brazil (Bayer 1951) (Table 2).

Pacifigorgia adamsii (Verrill, 1868c),
new combination

Figs. 4A, B, 5A, 14A–E

Rhipidogorgia agassizii Verrill, 1864:32–33 (partial).

Gorgonia (Rhipidogorgia) agassizii Verrill, 1866:327 (partial).

Gorgonia (Litigorgia) adamsii Verrill, 1868a:415 (partial).

Litigorgia adamsii Verrill, 1868b (partial).—Verrill, 1869b:422 (partial).

Leptogorgia adamsii Verrill, 1868c:391, Pl. 4, Fig. 4; Pl. 5, Fig. 5 (partial).—Verrill, 1869b:421.—Studer, 1891:86.

(?)*Gorgonia adamsii*.—Hickson, 1928:380–383.

Gorgonia adamsii.—Bielschowsky, 1918:38 (partial).—Kükenthal, 1919:773 (partial).—Kükenthal, 1924:338–338 (partial).—Bielschowsky, 1929:146 (partial).

Material examined.—*Lectotype* (here designated).—YPM 1173 k, dry specimen, 76.8 by 114.4 mm, Pearl Islands, Gulf of Panamá, Panamá, depth 11–15 m, collector F.H. Bradley, 1866–67.

Paralectotypes.—YPM 1173 d, m, n, o; MCZ 1173, 4032 Pearl Islands, Gulf of Panamá, Panamá; MCZ 4031 (MCZ 391), MCZ 4031 (MCZ 374), MCZ 4032 (MCZ 375) Panamá.

Other material.—MCZ 4013, 4026 (15), 4027 (3), 4029 (2), 4030, 5044, Panamá; MCZ 4028, Acapulco, Mexico; YPM 1643, 554, 4616, Bay of Panamá; USNM 34059, Bay of Panamá; CASIZ 097955, Baja California; CASIZ 097758, Sinaloa, Mazatlán; CASIZ 097905, Revillagigedo Islands; CASIZ 100844, Los Frailes Bay, Baja California; UCR 924 (2), 925, 931, 934, Sámará Bay; UCR 488, Herradura; UCR 932, 933 Caño Island, Costa Rica.

Preliminary remarks.—This species was first mentioned as *Gorgonia (Litigorgia) adamsii* (Verrill, 1868a) without any description. The species was properly de-

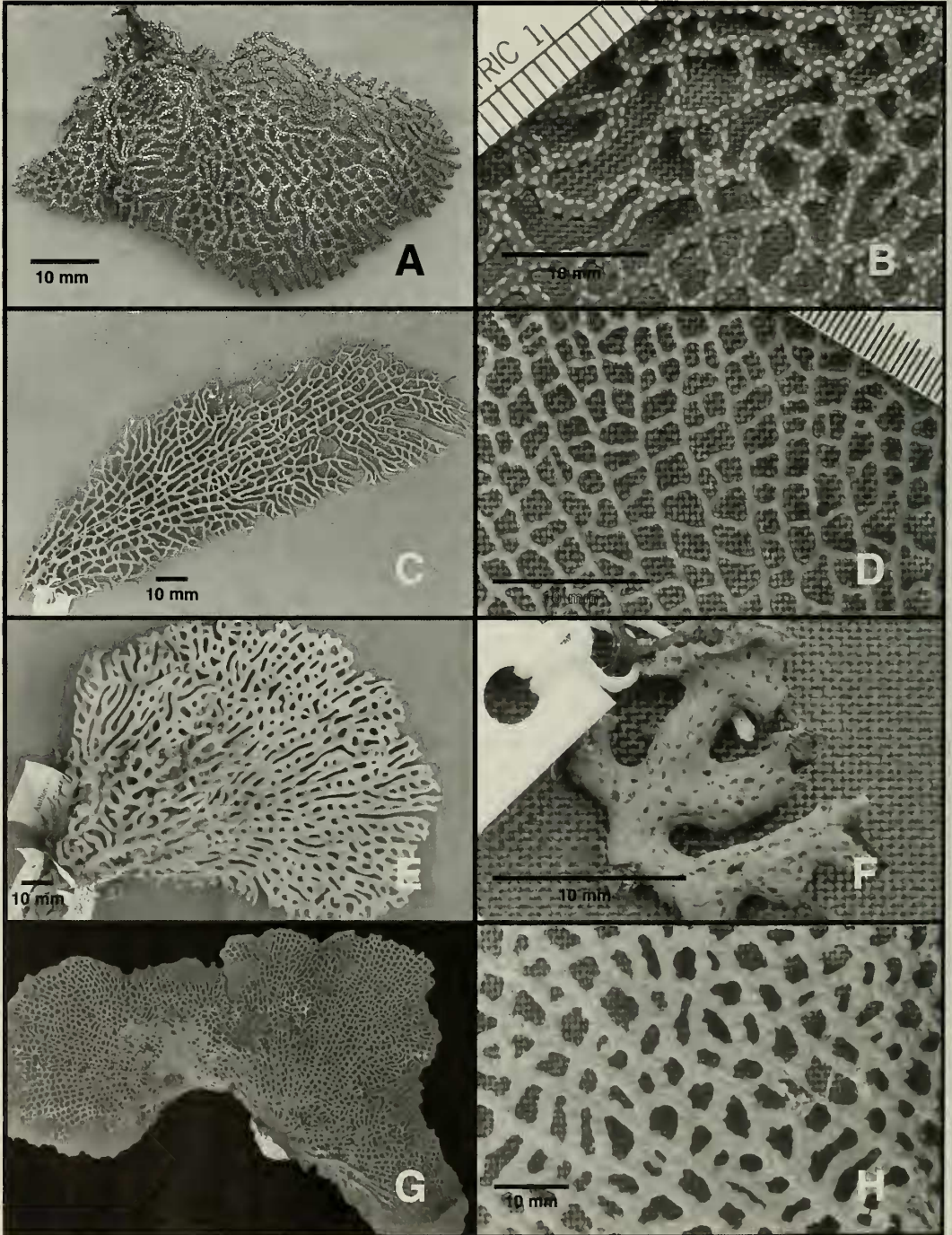


Fig. 6. A–B. *Pacifigorgia darwinii* (BM 1930.6.17.10). C–D. *Pacifigorgia elegans* (YPM 4554). E–F. *Pacifigorgia engelmanni* (YPM 388). G–H. *Pacifigorgia exilis* (YPM 4059a). A, C, E, G. Entire colonies. B, D, F, H. Detail of the branches.

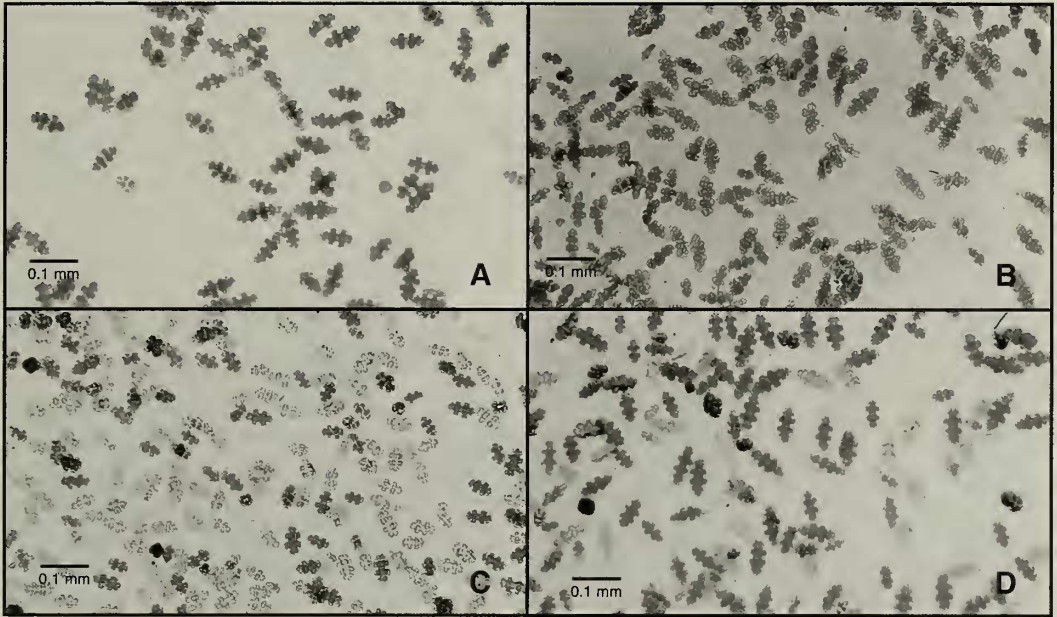


Fig. 7. A–H. Photomicrographs of sclerites. A. *Pacifigorgia darwinii* (BM 1930.6.17.10). B. *Pacifigorgia elegans* (YPM 4554). C. *Pacifigorgia engelmanni* (YPM 388). D. *Pacifigorgia exilis* (YPM 4059a).

scribed in 1868b, when Verrill raised *Litigorgia* to genus level. The same year he transferred the species to the genus *Leptogorgia* (1868c). *Leptogorgia adamsii* was described using a collection of specimens from various localities: Pearl Islands, Panamá; Zorritos, Perú; Punta Arenas and Corinto, Nicaragua. Verrill did not designate a holotype. Previously, in 1864, Verrill had described the species *Rhipidogorgia agassizii*, without designating a holotype, from a mixture of specimens from Acapulco and Panamá. In 1868b, 1868c he came to the conclusion that he had included two other different species, *Leptogorgia adamsii* and *Leptogorgia rutila* in his material assigned to *R. agassizii*, and described both species. He included “*R. agassizii* (partial)” in the synonym list of these three species. The 276mixture of specimens in the collection does not permit to make sure on which specimens Verrill had based the description of *adamsii* in 1864. We found several specimens in the MCZ collection that could have been his original material: two specimens (MCZ 4031) collected by Sternberg

from Panamá, with 2 names on the labels (*Rhipidogorgia agassizii* and *Litigorgia adamsii*); one specimen (MCZ 4032) with the same data and an indication that it was 1 of 3. Two specimens (MCZ 4035a, b), without any labels (see under *Pacifigorgia agassizii*). Two other specimens from Acapulco (MCZ 4035, MCZ 4035c) with original labels and identified as *Gorgonia media*. One specimen from Acapulco without original label (MCZ 7010) (see under *Pacifigorgia rutila*). And finally, one specimen (MCZ 1173) with original label, and identified as *Leptogorgia adamsii*, from Pearl Islands, Panamá, collected by Bradley, and given to the MCZ by YPM in exchange. In Yale we found another series of specimens (YPM 1173d, k, m, n, o), from Pearl Islands, Panamá; which was properly identified and labeled, and clearly was part of the original material used by Verrill when he described *Leptogorgia adamsii*.

In 1951 Bayer discovered that Verrill’s material of *Leptogorgia adamsii* also included another species, that was considered

by Verrill to be the "adult specimens" of species, and described *Pacifigorgia irene*.

The circumstances make it necessary to designate a lectotype in order to avoid future confusion. Because of the above-mentioned mixture of specimens in the MCZ collection, and following recommendation 74D (ICZN 1999–2000:84) we hereby designate YPM 1173k as the lectotype of *Litigorgia adamsii* Verrill 1868a. It is the specimen that shows best the characters of the species as described by Verrill 1868b and 1868c.

Diagnosis.—Colonies small, dark purple or golden ochre, wider than high, up to 210 mm long, 210 mm wide, normally formed of a single erect fan with margins rounded or lobed. Finely and evenly reticulated. Thin squarish branches (up to 0.8 mm diameter). Network of square, polygonal, and sometimes round meshes, between 1 and 2.5 mm wide. Short stem (up to 20 mm) and no trace of strong midribs, just some short thick branches at the base. Very short free-branchlets (up to 3 mm long). Pointed, slightly raised calyces occur in two alternating rows evenly spaced on all sides of the branches, producing a warty surface. Coenenchymal sclerites red, yellow, colorless, and some bi-colored. Long spindles (0.09–0.13 by 0.03–0.04 mm) with acute ends. Anthocodial rods yellow or light orange (0.06–0.10 mm by 0.01–0.03 mm) with scalloped or serrated borders and small thorny warts.

Description of the lectotype.—The specimen (Fig. 4A, B) is a purple, 76.8 mm long, 114.4 mm wide, semicircular fan, wider than high, composed of a single erect fan. A short stem (around 10 mm diameter and 10 mm in length) arises from a circular holdfast and then divides in 3 thicken branches, which blend shortly into the fan. No strong midribs cross the fan. The branches, in cross section, are squarish and uniform (0.5–0.8 mm in thickness). They repeatedly branch to form a fine network, mostly of square and polygonal meshes (1–2.5 mm). Terminal free-branchlets are very

short, 0.5 to 3 mm long. Calyces are low pointed mounds, arranged in two alternating rows evenly around the branches, and in rows of pairs at the thicker branches and the meshwork (Fig. 4B). The diameter of the calyx ranges from 0.32–0.37 mm. Coenenchymal sclerites are red, yellow or colorless, and some are bi-colored. They are long, slender spindles (0.09–0.13 by 0.03–0.04 mm) with acute ends and 4 or 6 whorls of warty tubercles, and warty ends (Fig. 14A), blunt spindles (0.06–0.09 by 0.03–0.04 mm), (Fig. 14B), capstans (0.03–0.06 by 0.02–0.03 mm) (Fig. 14C), and rods (0.04–0.06 by 0.02–0.03 mm) with smooth tubercles (Fig. 14D). Anthocodial sclerites are yellow or light orange flat rods (0.06–0.10 by 0.01–0.03 mm), with borders scalloped or serrated and small thorny warts (Fig. 14E).

Variability.—The color of the specimens vary from golden yellow to deep purple. Some specimens could have one or two small fans radiating perpendicular to the main fan. The largest specimens found reach 210 by 210 mm in size.

Remarks.—Verrill (1868c) included in the *Leptogorgia adamsii* synonyms list the species *Rhipidogorgia ventalina* Duchassaing & Michelotti, 1864. He pointed out that it is different from *Gorgonia ventalina* Linnaeus, Esper or Pallas. Although his observation was correct, the species of Duchassaing & Michelotti (1864) is also different from *P. adamsii*, which has a very close knitted meshwork, and more prominent calyces, unlike the species described by those authors. Additionally, Hickson (1928) remarked that *R. ventalina* did not agree with *Leptogorgia adamsii* of Verrill (1868c) because its color can not be described as "d'un beau rouge", and also wrote that *R. ventalina* might be *Gorgonia agassizii*. However, from the illustration of *R. ventalina* provided by Duchassaing & Michelotti (1864:20, Pl. 4, Fig. 3) and the fact that to date the only *Pacifigorgia* found in the Atlantic is *P. elegans*, it is clear that it is neither *adamsii* nor *agassizii*. Consequently, it

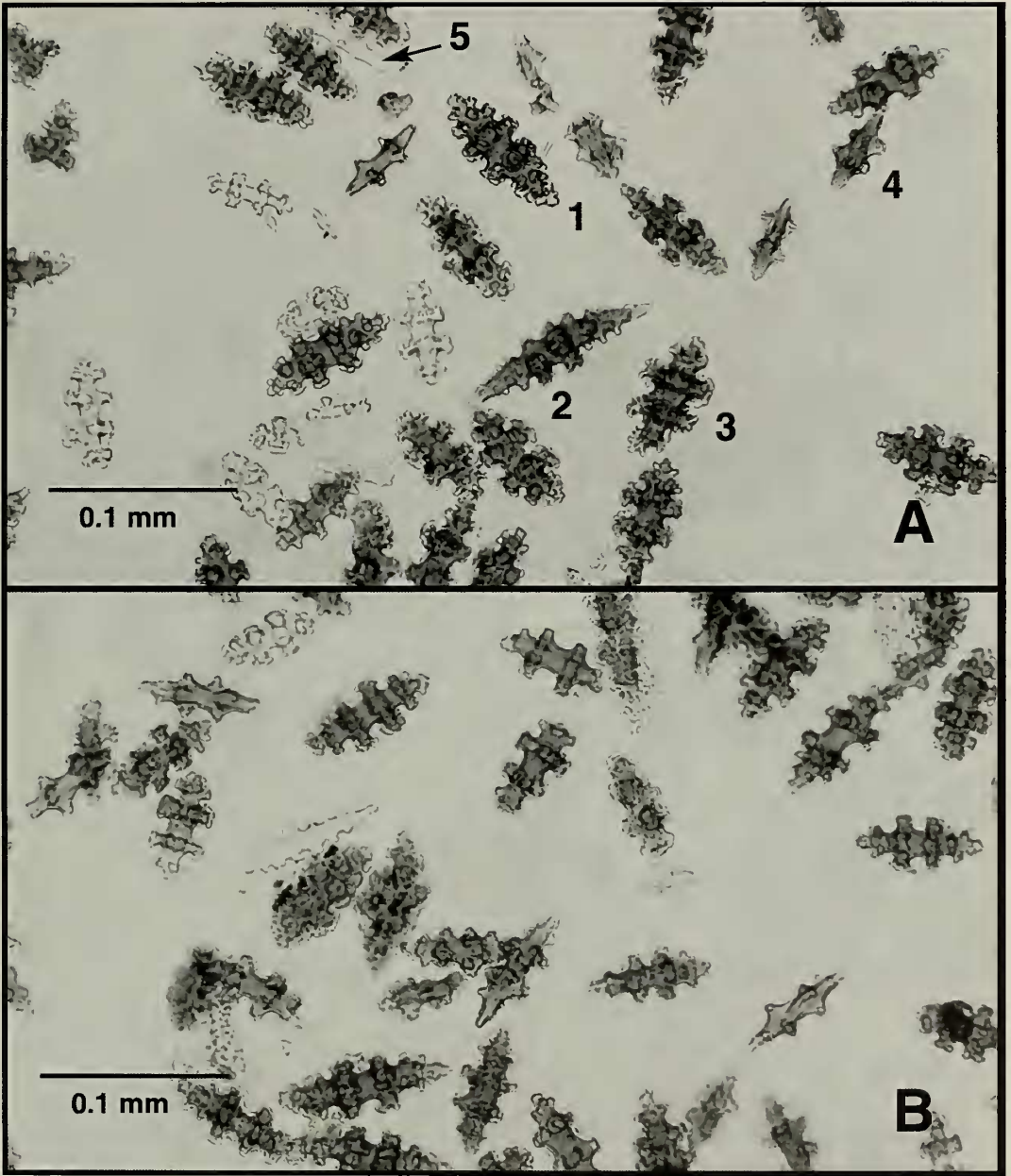


Fig. 8. A–B. Photomicrographs of sclerites of *Pacifigorgia douglasii* (BM 1961.2.6.161, 162). 1. Blunt spindle. 2. Spindle with acute ends. 3. Capstan. 4. Rod with flat tubercles. 5. Anthocodial rod.

is not included as a synonym of *P. adamsii* anymore.

Pacifigorgia adamsii, *P. agassizii*, *P. cribrum*, *P. rutila* and *P. irene* are the only species of the genus which develop fans with a very close knitted meshwork. The

meshwork of *P. cribrum* and *P. rutila* are the finest, 0.25–2 mm diameter; in *P. irene* it is 1.5–2 mm; in *P. adamsii* around 2.5 mm; and in *P. agassizii* up to 2.8 mm (Table 1). *Pacifigorgia adamsii*, *P. rutila* and *P. cribrum* do not have strong midribs

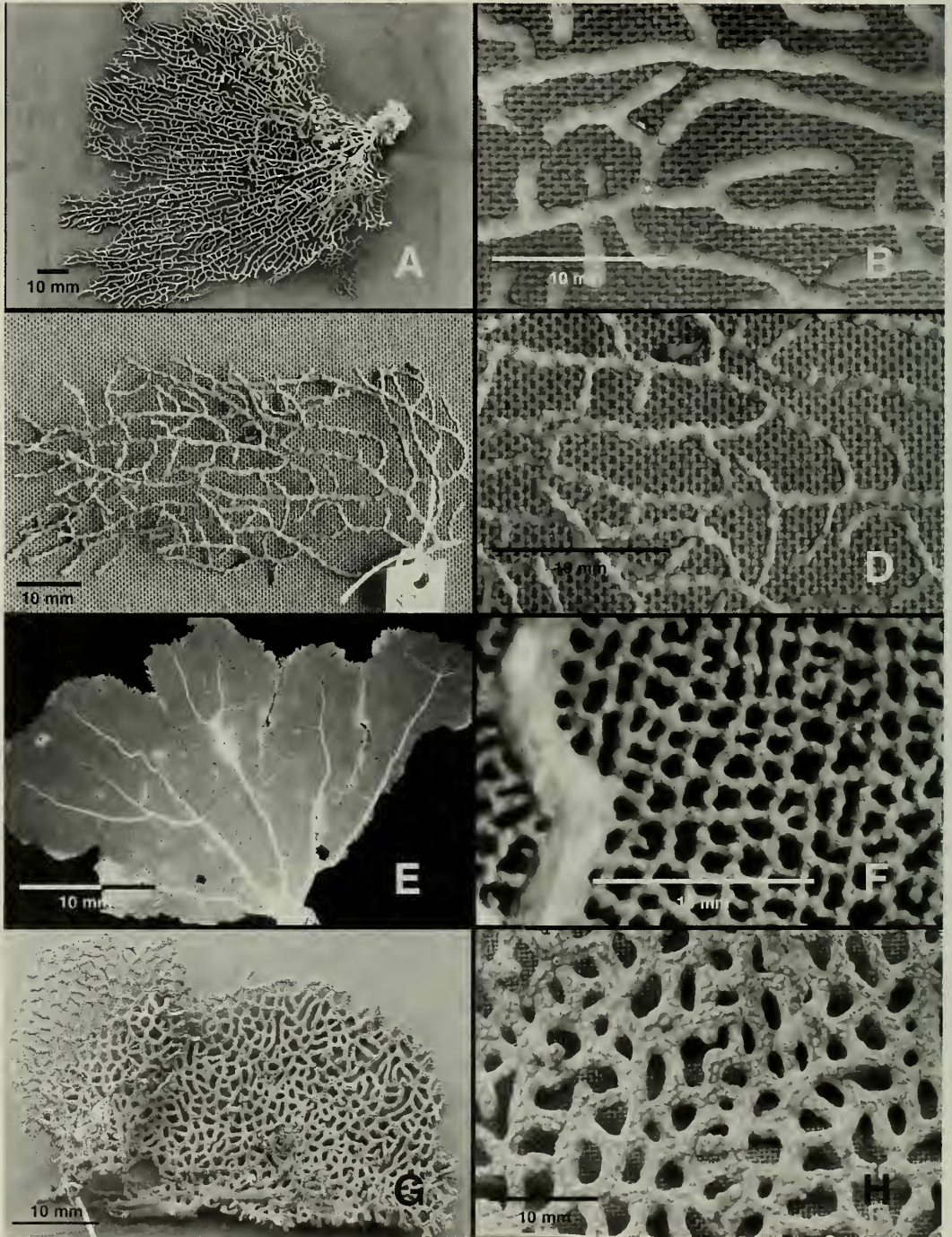


Fig. 9. A-B. *Pacifigorgia eximia* (YPM 1550a). C-D. *Pacifigorgia gracilis* (YPM 8745). E-F. *Pacifigorgia irene* (USNM 33611). G-H. *Pacifigorgia media* (YPM 955). A, C, E, G. Entire colonies. B, D, F, H. Detail of the branches.

crossing the fans, as in *P. irene* and *P. agassizii*. *Pacifigorgia adamsii* has more prominent calyces than *P. cribrum* and *P. rutila* and has a purple or gold yellow color, not the characteristic burnt orange of *P. rutila* or the reddish brown of *P. cribrum* (Table 1). The anthocodial rods vary in these species; those of *P. irene* are shorter (up to 0.09 mm) and flatter than the ones in *P. adamsii* (up to 0.10 mm) and are also colorless. In *P. agassizii*, the anthocodial rods are yellow and smaller (up to 0.085 mm) than the ones in the other two species. In *P. rutila* they are the largest (up to 0.12 mm) (Table 1). The coenenchymal sclerites are red, yellow and bi-colored in *P. adamsii*, *P. cribrum*, and *P. agassizii*, red and pale yellow in *P. irene*, and pink or light orange in *P. rutila* (Table 1). They are mostly spindles with acute ends in *P. adamsii* and *P. irene*, but mostly blunt spindles in *P. agassizii*, *P. rutila* and *P. cribrum*.

Hickson (1928) studied two specimens he identified as *P. adamsii* from Panamá, one from Balboa and the other from Taboga. He pointed out some differences, did not consider them different species. From his descriptions, it is possible to tell that those specimens, although fragments, fit better *P. irene* than *P. adamsii*. Verrill's (1868c) and Hickson's (1928) illustrations and descriptions are not sufficient to recognize *P. adamsii* since only one kind of sclerite is described, and the anthocodial rods were not taken into account.

Distribution.—Acapulco, Mazatlán, México; Corinto, Nicaragua; Puntarenas, Costa Rica; Pearl Islands, Panamá; Zorritos, Perú (Verrill 1868c); Balboa, Taboga, Panamá; Sámara Bay and Caño Island, Costa Rica (pers. obs.) (Table 2).

Pacifigorgia agassizii (Verrill, 1864),

new combination

Figs. 4C–D, 5B, 15A–F

Rhipidogorgia agassizii Verrill, 1864:32–33 (partial).

Rhipidogorgia media Verrill, 1864:33 (partial).

Gorgonia (*Rhipidogorgia*) *agassizii* Verrill, 1866:327 (partial).

Gorgonia (*Rhipidogorgia*) *media* Verrill, 1866:327 (partial).

Litigorgia agassizii Verrill, 1868a:414.—Verrill, 1868c:388.

Leptogorgia agassizii Verrill, 1868c:388–389, Pl. 5, Fig. 4.—Verrill, 1869b:421.—Verrill, 1870:548–549.

Gorgonia agassizii.—Bielschowsky, 1918:38.—Kükenthal, 1919:773.—Kükenthal, 1924:339.—Hickson, 1928:379.—Bielschowsky, 1929:146.

(?)*Gorgonia agassizii*.—Hickson, 1928:379–380.

not *Pacifigorgia agassizii*.—Prahl et al., 1986:15–16, Fig. 2.

Material examined.—MCZ 4035 a, b, dry specimen, 350 by 280 mm, Acapulco?, México, no more data; YPM 956 a, b, MCZ 4014, MCZ 36265, Cape San Lucas, México; MCZ 4015, Mazatlán, México; YPM 4064a, b, YPM 4053 a, b; YPM 4062 c, USNM 49369, USNM 1677, La Paz, Baja California; USNM 79433, Los Arcos, México; USNM 34067, no data; USNM 57901, 57902, Socorro Island, México; CASIZ 0480B, 100842, 100844, 1009840, 100838, Los Frailes Bay, Baja California, CASIZ 104126, Socorro Island, CASIZ 097728, CASIZ 097906, Clarion Island, Revillagigedo Islands, CASIZ 096908, 096909, 096897, 096911, 096912, 097777, 097775, Cape San Lucas, CASIZ 096906, 0969813, 103217, Cerralvo Island, Baja California, CASIZ 73816, Baja California, México.

Preliminary remarks.—Verrill described *Rhipidogorgia agassizii* in 1864, from a mixture of specimens from Acapulco, Mexico collected by A. Agassiz and D. B. Vanbrunt, and from Panamá collected by J. H. Sternberg. The material from Panamá (MCZ 4031) was identified later by Verrill (1868c) as *Leptogorgia adamsii* (see above), but it is not possible to be certain about the other specimens. Two large spec-

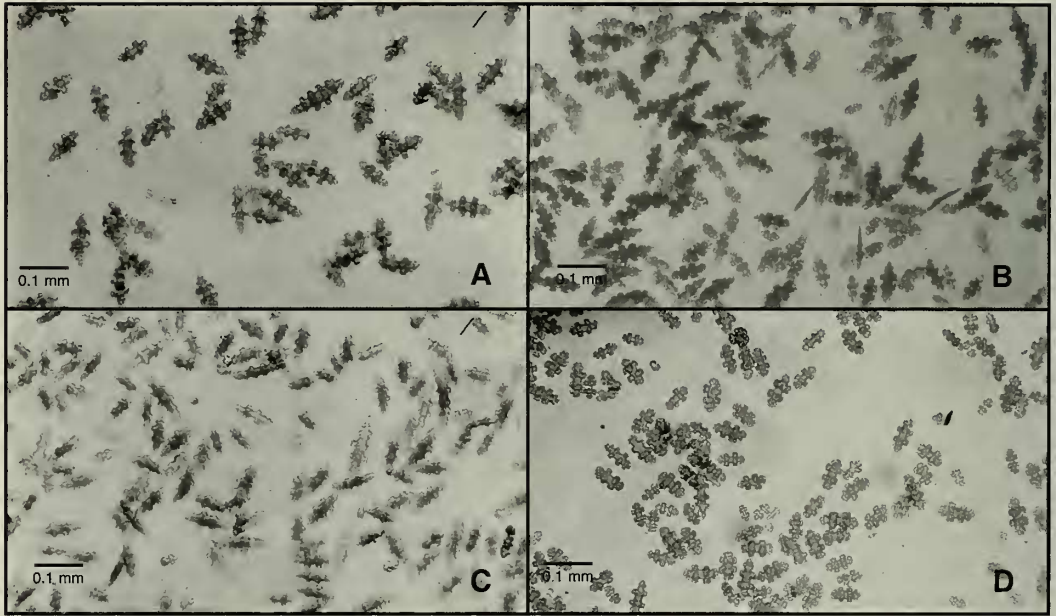


Fig. 10. A–D. Photomicrographs of sclerites. A. *Pacifigorgia eximia* (YPM 1550a). B. *Pacifigorgia gracilis* (YPM 8745). C. *Pacifigorgia irene* (USNM 33611). D. *Pacifigorgia media* (YPM 955).

imens up to 40 cm high by 40 cm wide, MCZ 4035a and 4035b are without original labels. E. Deichmann identified them as *Rhipidogorgia agassizii*, who attached a red tape with her handwriting “type”, but neither locality nor a collector was recorded. These specimens were put together with MCZ 4035, the holotype of *Rhipidogorgia media* Verrill, that has an original label “Acapulco”, collected by Agassiz. Verrill properly defined *Leptogorgia agassizii* in 1868b and 1868c with specimens from Acapulco, Cape San Lucas, and La Paz. The status of the two large colonies remains uncertain, although the suspect arises they could be the syntypes. The specimen YPM 956a (from La Paz) is doubtless conspecific with them and fits closely Verrill’s 1868b description; Verrill had added a label “type”, but it cannot be the type of the species that he described in 1864 on material from Acapulco. The specimen YPM 956a from La Paz, illustrated here, and the ones of MCZ 4035 are doubtless Verrill’s authentic material.

Description.—Colonies large, deep or-

ange, with yellow intermingled, wider than high, with single or complex fans up to 400 mm long and 400 mm wide. Rounded branches, 1–1.2 mm in cross section. Finely and evenly reticulated as a network of square, oblong or round meshes, up to 2.8 mm in diameter. Stem very short, several flat and strong midribs are present. End-branchlets very short, 1–3 mm long with expanded tips. The calyces are distinct yellow, slightly raised mounds with oval openings. They are closely arranged, mostly in pairs along the edges of the branches, very crowded, producing a warty surface. They are scattered and more distant at the midribs and the thicker branches. Coenenchymal sclerites are deep red, bright yellow, colorless, and a few bi-colored, mostly blunt and thick. The longest sclerites are thick spindles (0.09–0.11 by 0.04–0.05 mm) with acute ends and 2 whorls of warty tubercles, and with the ends ornamented with many small warts (Fig. 15A). The other spindles are shorter: blunt ones (0.07–0.10 by 0.04–0.05 mm) with 2 complete whorls of warty tubercles and incomplete spirals of warts at

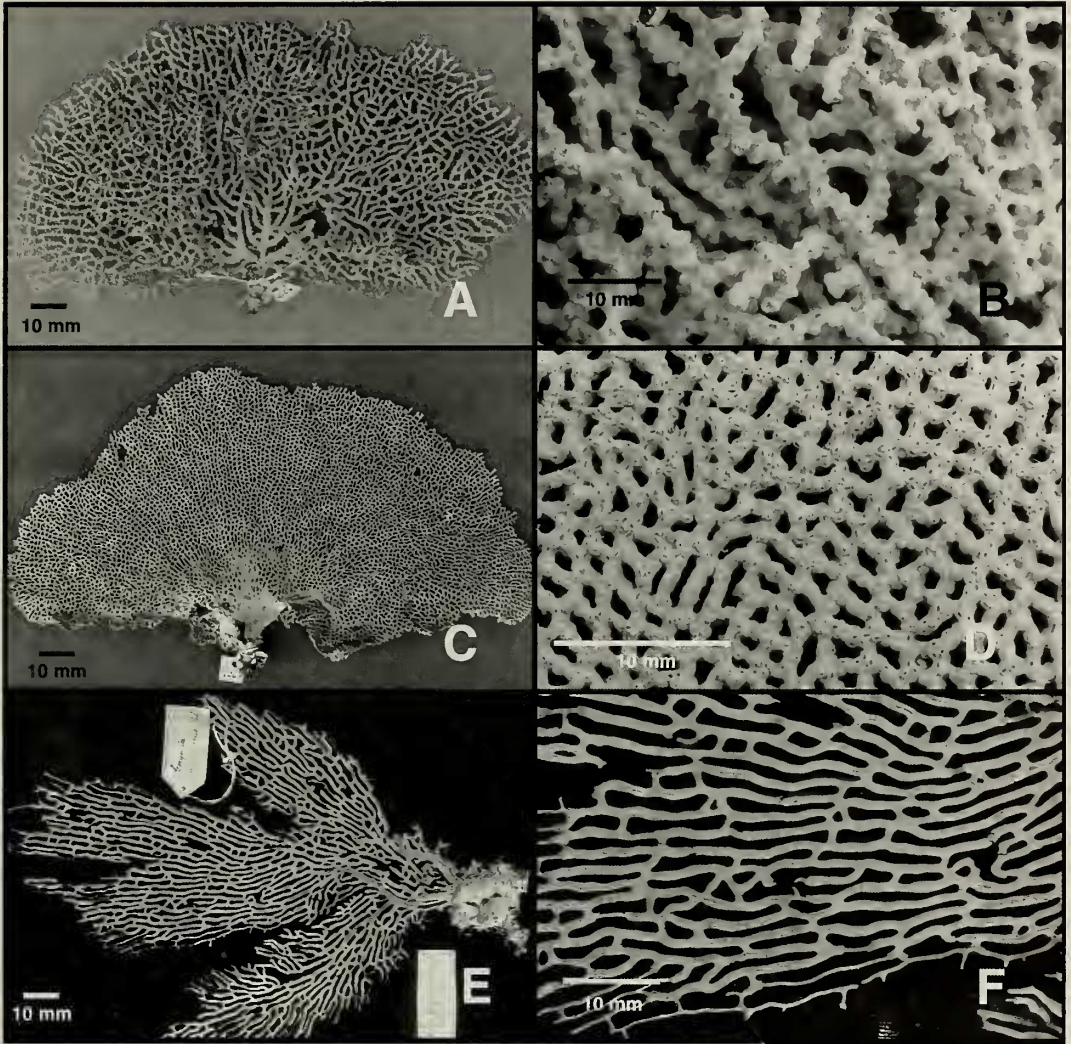


Fig. 11. A–B. *Pacifigorgia pulchra* (YPM 4058b). C–D. *Pacifigorgia rutila* (YPM 2266). E–F. *Pacifigorgia stenobrochis* (MNHN OCT.S.2000.03). A, C, E, G. Entire colonies. B, D, F, H. Detail of the branches.

the ends (Fig. 15B). The capstans vary in size and ornamentation (0.04–0.07 by 0.02–0.04 mm) (Fig. 15C), the rods (0.04–0.08 by 0.02–0.04 mm) have flat tubercles (Fig. 15D). There are conspicuous modified capstans with complex tuberculate ends (Fig. 15E). Anthocodial rods are yellow (0.05–0.09 by 0.02–0.03 mm) with scalloped or serrated borders, and small rods with thorny warts (Fig. 15F).

Variability.—The colonies of *Pacifigorgia agassizii* can be composed of numerous and more or less united fans, forming com-

plex large rosettes. Some colonies are composed by five to ten small fans; which are joined together by the midribs, just at the base. In small specimens the midribs are more rounded and can be traced up to one fourth of the colony, while in the large ones, they are flatter and thicker and cross the fans extending, in some cases, up to the borders. Longitudinal yellow and intense red grooves appear on the thick midribs of some colonies. The colonies can be of a deep yellow color (USNM 57901, 57902).

Remarks.—The studied specimens agree

closely Verrill's description; even though, the size of the acute-ended and blunt spindles given by Verrill (1868a) is somewhat different. This species has been confused with *P. adamsii*, *P. cribrum* and *P. rutila*. In fact, the specimen MZC 4031, from Panamá identified with both names, *Rhipidogorgia agassizii* and *Litigorgia adamsii* is *P. adamsii*, and the fragment MCZ 7010 from México (labeled *R. agassizii*) is probably *P. rutila*, not *P. agassizii*, and the specimen USNM 79433 identified as *P. cribrum* is *P. agassizii*. Differences between these species, and *P. agassizii* were discussed above. Hickson's description of *G. agassizii* is not clear, so it is difficult to know which species he described, but anyway, the kind of sclerite he illustrated (Hickson 1928) is not typical of Verrill's species. Colonies from Bahía Málaga, Colombia identified as *P. agassizii* by Prahl et al. (1986) do not match this species.

Distribution.—Cape San Lucas, La Paz, Baja California, Mazatlán Acapulco, Los Arcos, Socorro Island, México; Rey Island, Panamá (Verrill 1868c) (Table 2).

Pacifigorgia arenata (Valenciennes, 1846),
new combination
Figs. 4E, F, 5C, 16A–F

Gorgonia arenata Valenciennes, 1846: Pl. 12 Figs. 1, 1a, Pls. 13, 14.—Kükenthal, 1919:774 (“nomen dubium”).—Kükenthal, 1924:340.—Bielschowsky, 1929: 157.

Rhipidigorgia (misspelled) *arenata*.—Valenciennes, 1855:13.—Milne Edwards & Haime, 1857:176.

Leptogorgia arenata.—Verrill, 1869b:422.

Material examined.—*Holotype*.—MNHN dry specimen, 90 by 195 mm, New Zealand, no depth given, 1839, collector, Voyage de la Vénus, Capitaine Du Petit-Thouars.

Preliminary remarks.—Valenciennes (1846) illustrated three species of *Pacifigorgia* collected in the Voyage de la Vénus (1836–1839), told to be from New Zealand: *P. arenata*, *P. cribrum*, and *P. stenobrochis*.

The reported locality was probably a mistake (Verrill 1868c). Following the cruise track of the Vénus (H. Zibrowius, pers. comm. 2000), it is very likely that this material was collected either from Acapulco or Mazatlán, on the vessel's route in the American Pacific, and not New Zealand. There are no shallow waters gorgonians in New Zealand and the waters are very cold (P. Alderslade, pers. comm. 2001). Apart from the beautiful illustrations of these species in Valenciennes' (1846) publication, there is no description of any of them. The holotype in the MNHN is the only specimen known so far; its characters are sufficiently distinctive to keep it apart of all other species.

Description of the holotype.—The colony is wider than high, 95 mm long 149 mm wide; it is reddish with yellow calyces. It has two long branches. Strong midribs are absent, only one thick branch extends a short way into the fan (2–4 mm diameter). The branches are rounded in cross section (1–2.5 mm); they anastomose to form an open network of square and polygonal (1–22 by 1–4 mm) and some round (1 mm diameter) meshes (Fig. A, B). End-branchlets from 1–10 mm in length with wide tips. Free twigs from 1–5 mm long. The calyces are not prominent. They are not very crowded and are arranged in two longitudinal rows on both sides of the branches. Coenenchymal sclerites are red and yellow and a few bicolor. They are wide spindles (0.09–0.10 by 0.04–0.05 mm), some with acute warty ends (Fig. 16A), wide blunt spindles (0.07–0.08 by 0.03–0.04 mm) with 2–4 whorls of tubercles or separate warts (Fig. 16B); pointed rods (0.06–0.08 by 0.02–0.03 mm) with flat tubercles (Fig. 16C); capstans (0.05–0.07 by 0.02–0.04 mm) with complete whorls of globose tubercles or with separate warty ones (Fig. 16D), and some four-radiates, like tuberculate crosses (0.05–0.06 by 0.05–0.06 mm) (Fig. 16E). Anthocodial sclerites are pale yellow flat rods (0.05–0.10 by 0.01–0.02 mm), with scalloped, dented or lobed borders (Fig. 16F).

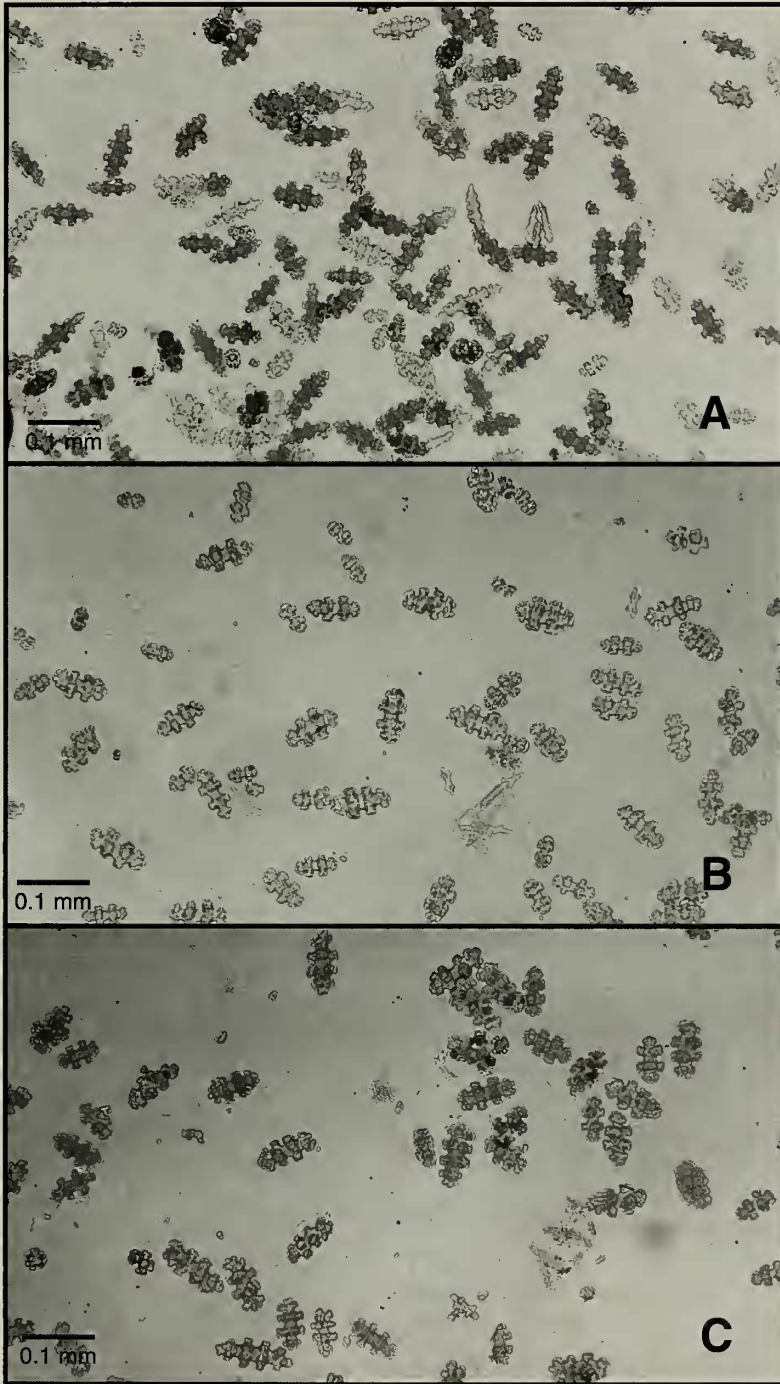


Fig. 12. A–D. Photomicrographs of sclerites. A. *Pacifigorgia pulchra* (YPM 4058b). B. *Pacifigorgia rutila* (YPM 2266). C. *Pacifigorgia stenobrochis* (MNHN OCT.S.2000.03).

Remarks.—The only specimen found was the holotype, which is different from the other species. We decided to keep this species separated until more specimens are located for comparison.

Distribution.—Acapulco or Mazatlán, not New Zealand as originally reported.

Pacifigorgia bayeri Breedy, 2001

Material examined.—*Holotype.*—UCR 922, wet specimen, 134 mm by 290 mm, Caño Island, Bajo Diablo, Costa Rica, 10–12 m, coll. O. Breedy, 2000.

Paratypes.—UCR 949; UCR 950; UCR 951, Caño Island, Costa Rica.

Description. (details see Breedy 2001).—Colonies wider than high, up to 350 mm by 420 mm, of a characteristic deep yellow color intermingled with dark purple. Single and complex fans of thick network with closed rounded and oblong meshes (around 2–5 mm in diameter), wide and strong hold-fasts and no distinct midribs. Branches up to 1.5 mm thick. Slightly raised calyces surrounded by rings of yellow sclerites. They are crowded and distributed mostly in pairs around the branches. Red, and bright yellow coenenchymal sclerites: blunt spindles (0.07–0.11 by 0.03–0.05 mm); few wide spindles with acute ends (0.09–0.12 by 0.05–0.06 mm); various kinds of capstans (0.03–0.1 by 0.02–0.06 mm); wide and conspicuous (0.08–0.1 by 0.05–0.06 mm); and small, and abundant (0.03–0.04 by 0.02–0.02 mm). Rods with flat tubercles (0.04–0.08 by 0.02–0.05 mm). Yellow, or pink anthocodial rods (0.05–0.10 by 0.02–0.04 mm) with lobed or scalloped margins.

Remarks.—Some similarity to *Pacifigorgia exilis* (Verrill, 1870) and *Pacifigorgia tabogae* (Hickson, 1928) was discussed (Breedy 2001). *Pacifigorgia bayeri* has only been found at the type locality.

Pacifigorgia cribrum (Valenciennes, 1846)
Figs. 4G–H, 5D, 17A–E

Gorgonia cribrum Valenciennes, 1846: pl. 13 figs. 1–3.—Bielschowsky, 1918:38.—

Kükenthal, 1919:773.—Kükenthal, 1924: 340.—Bielschowsky, 1929:150.

Rhipidigorgia (misspelled) *cribrum*.—Valenciennes, 1855:13.—Milne Edwards & Haime, 1857:175.

Leptogorgia cribrum.—Verrill, 1869b:421.

Pacifigorgia cribrum (new combination).—Bayer & Macintyre, 2001:318 (mineralogy).

Material examined.—*Holotype.*—USNM 49567 (fragment of the holotype), MNHN dry specimen, 170 by 135 mm, “New Zealand”, no depth given, 1839, collector, Voyage de la Vénus, Capitaine Du Petit-Thouars; MM. Quoy et Gaimard, 1829, cf. étiquette “*Rhipidigorgia cribrum* Val.”

Preliminary remarks.—Apart from the illustrations of this species in Valenciennes’ (1846) publication, there is no description. As mentioned above, the locality “New Zealand” was obviously a mistake.

Description of the holotype.—The specimen is a 170 by 135 mm higher than wide colony, of a reddish brown color. It is composed of two fans: a large one with a secondary fan sticking out perpendicular and spreading parallel. Except for some short thicker branches at the base of the fan, no distinct midribs are present. Branches are square in cross section, and slender throughout (0.5–1.0 mm thick). They regularly anastomose to form a fine network of tiny, mostly square (0.75–2.0 mm) meshes; some of them are totally filled by coenenchyme, especially at the basal part of the colony. The end-branchlets are quite small, less than 1 mm long. Calyces are reddish, rounded, and slightly raised, with asterisk-like apertures. They are arranged closely all around the branches (Fig. 4H). Coenenchymal sclerites are red, yellow and bicolored. They are long spindles (0.09–0.13 by 0.03–0.04 mm) with 2–4 whorls of tubercles and warty ends (Fig. 17A); blunt spindles (0.08–0.09 by 0.03 mm) with warty tubercles (Fig. 17B); capstans (0.03–0.07 by 0.02–0.04 mm) with smooth or warty tubercles (Fig. 17C); small six-radiates (0.04–

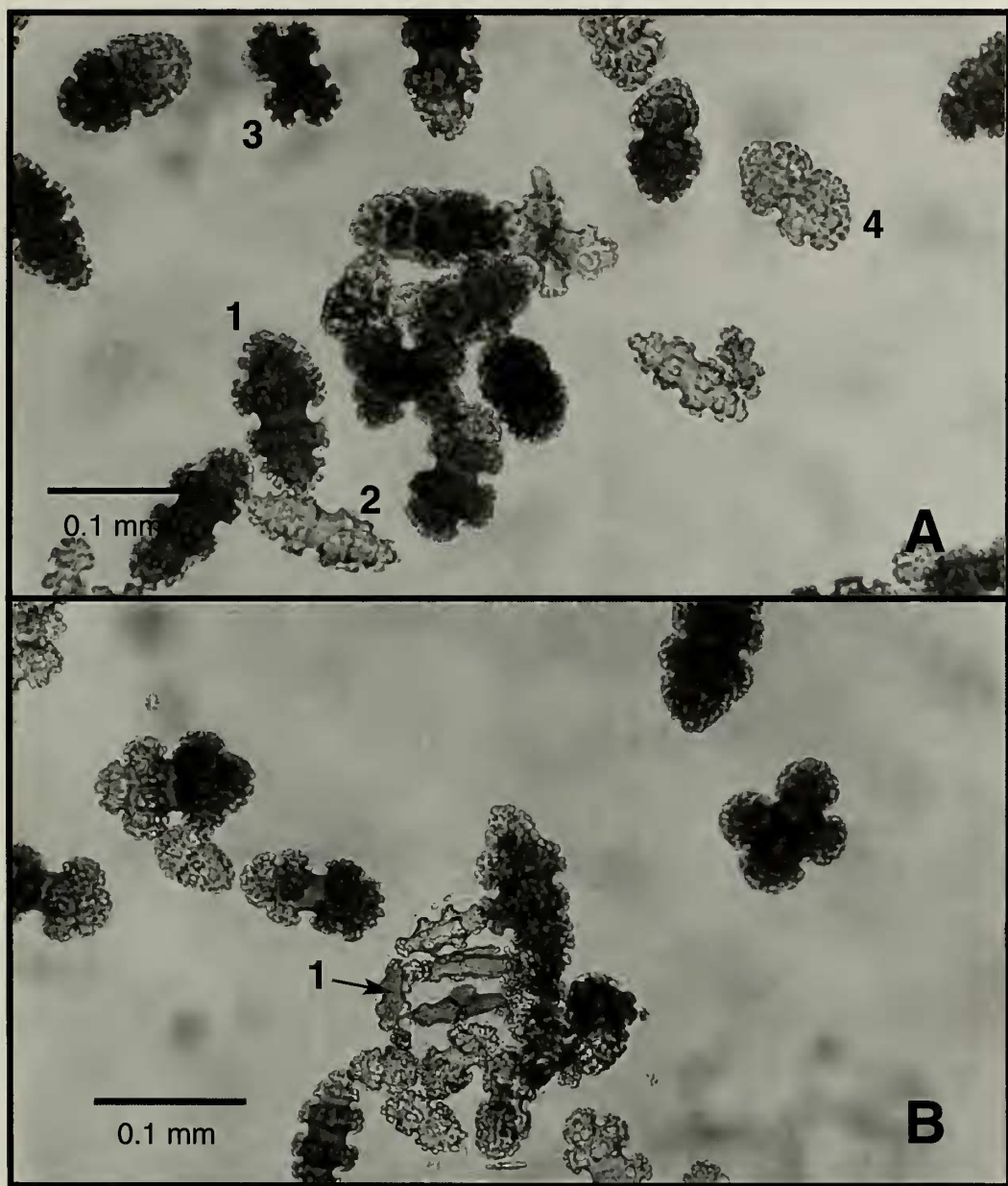


Fig. 13. Photomicrographs of sclerites of *Pacifigorgia tabogae* (BM 1961.2.6.163). A. 1. Spindle with acute ends. A. 2. Blunt spindle. A. 3. Four-radiate. A. 4. Capstan. B. 1. Anthocodial rod.

0.06 by 0.03–0.04 mm) (Fig. 17D), and rods with flat tubercles (0.05–0.07 by 0.02–0.03 mm) (Fig. 17E). Anthocodial sclerites are long yellow rods (0.05–0.09 by 0.01 mm), with smooth or slightly lobed borders.

Remarks.—*P. cribrum*, *P. rutila*, *P. adamsii* and *P. agassizii* are somewhat sim-

ilar and have been confused with one another (e.g., MCZ 7010, identified as *P. agassizii*, but re-examination proved it to belong to *P. rutila*; USNM 34067, identified as *P. cribrum*, belongs to *P. agassizii*). Differences between these species were discussed above. Bayer & Macintyre (2001)

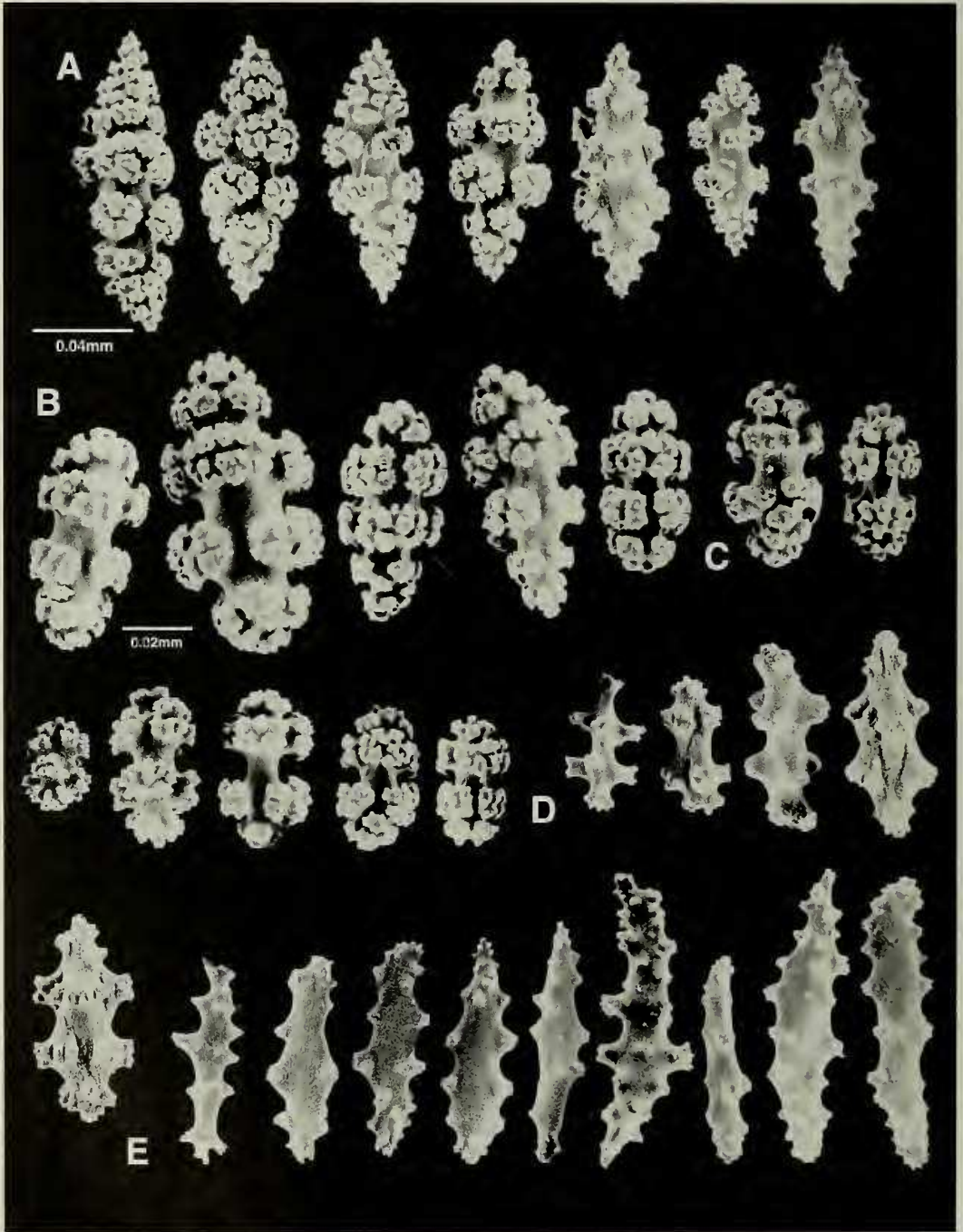


Fig. 14. *Pacifigorgia adamsii* (YPM 1173k); SEM micrographs of sclerites. A–D. Coenenchymal sclerites. E. Anthocodial sclerites. A. Spindles with acute ends. B. Blunt spindles. C. Capstans. D. Rods with tubercles. E. Rods.

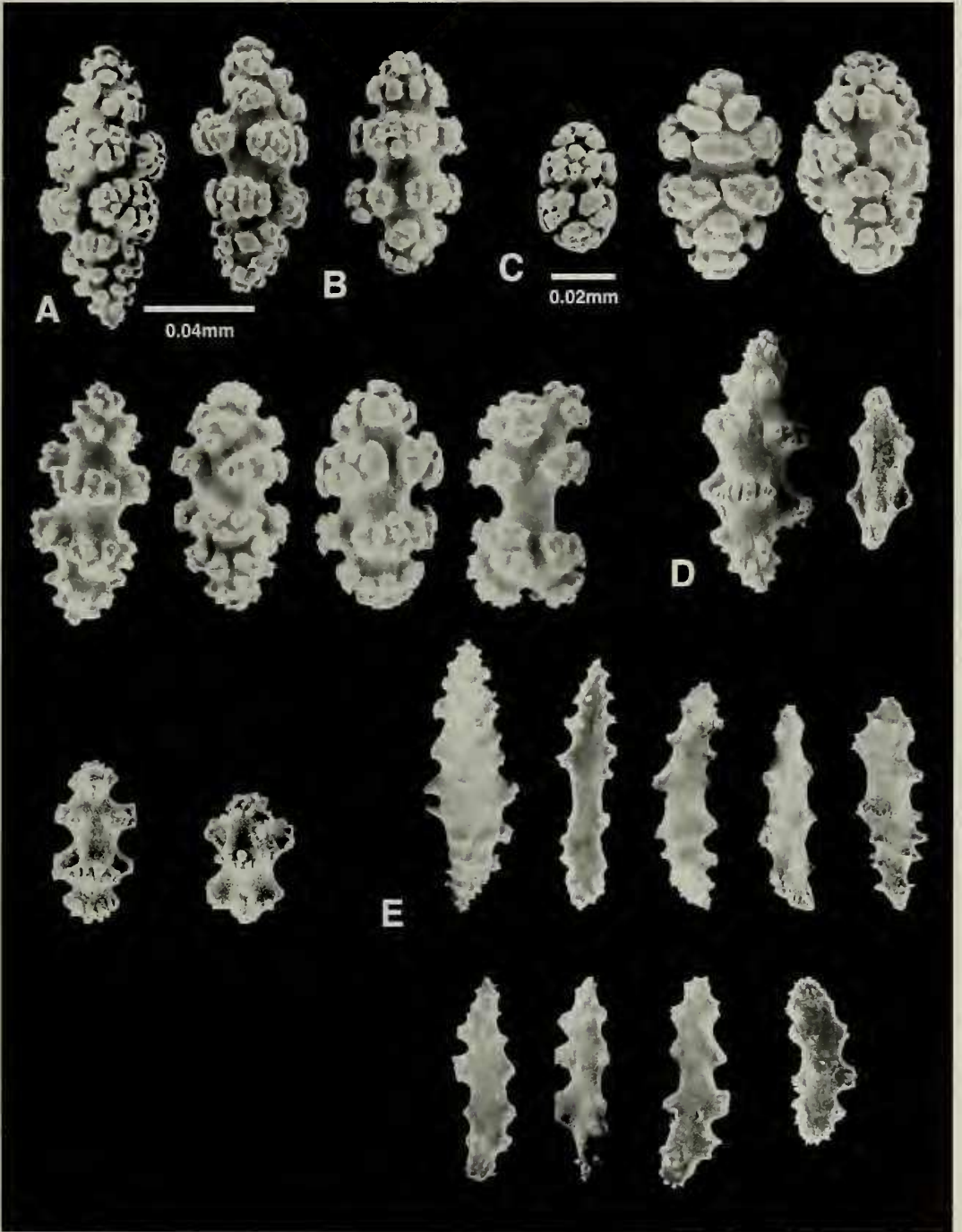


Fig. 15. *Pacifigorgia agassizii* (YPM 956a); SEM micrographs of sclerites. A-D. Coenenchymal sclerites. E. Anthocodial sclerites. A. Spindles with acute ends. B. Blunt spindle. C. Capstans. D. Rods with tubercles. E. Modified capstan. F. Rods.

made *P. rutila* synonym with *P. cribrum*, but based on the morphological differences found (Table 1), we decided to keep them as separate species until new material of *P. cribrum* is collected for comparison.

Distribution.—Acapulco or Mazatlán, not New Zealand as originally reported.

Pacifigorgia darwinii (Hickson, 1928),
new combination

Figs. 6A, B, 7A, 18A–F

Gorgonia darwinii Hickson, 1928:390–392, Pl. 4, Fig. 5, Pl. 6, Fig. 5, figure 26.—Stiasny, 1941:268–270, Figs. 2, 3.

Material examined.—*Lectotype* (here designated).—BM 1930.6.17.10, wet specimen, 95 by 149 mm, Tagus Cove, Albemarle, Galápagos Islands, no given depth, 1923–24, collector, C. Crossland, Scientific Expedition Research Assoc. Pacific Cruise.

Other material.—MCZ 34317, Gardner Isle, Galápagos Islands; 2 specimens (CASIZ, no catalogue numbers), Fernandina Island, Isabella Island; CASIZ 097117, CASIZ 097035, CASIZ 097031 (2), CASIZ 097032 (2), Isabella Island; CASIZ 097039, Fernandina Island; CASIZ 097019, San Cristóbal; CASIZ 105031, Galápagos Islands, Ecuador.

Preliminary remarks.—Hickson based the description of this species, apparently, on several specimens preserved in alcohol, and two dried specimens collected by C. Crossland in Tagus Cove, Albemarle. Although Hickson provided an illustration of a fragment of a colony (1928: Pl. 4, 5), it is not possible to reconcile any portion of the type colony with the drawing. He did not designate a holotype and only one specimen from his original series was found. In order to establish the identity of this species, we designated as the lectotype, the well-preserved specimen BM 1930.6.17.10.

Diagnosis.—Fans up to 250 mm, flat, dark purple, with yellow oval spots; open and evenly reticulated branching. Colonies composed by 2–3 parallel fans with short, thick branches on them. Flattened branches

(1.5–3 mm). Network of polygonal, and oblong, sometimes round meshes (2–13 by 2–3 mm). Very short stem, around 4 mm high, and no distinct midribs. Blunt free-branchlets from 2–10 mm long. Flat, oval yellow calyces mostly in two longitudinal rows along each side of the branches, only on one side of the colony, and in many rows (4–5) on the thick branches. Coenenchymal sclerites mostly purplish red, some yellow and very few bi-colored; blunt spindles (0.06–0.09 by 0.03–0.05 mm) and spindles (0.08–0.10 by 0.03–0.04 mm) with acute ends. Anthocodial sclerites flat, pale yellow rods (0.05–0.10 by 0.01–0.02 mm), with scalloped or lobed borders.

Description of the lectotype.—The colony is a wider than high fan, 95 mm long 149 mm wide; wet preserved it is dark purple with bright yellow spots, when dried its color fades. A very short stem, 4 mm long and 2 mm thick, arises from the small holdfast. Strong midribs are absent, only one thick branch extends a short way into the fan. Branches are relatively thick and flattened (1–2.5 mm); they anastomose to form an open network of polygonal (2–5 by 2–3 mm), oblong (5–13 by 2 mm) and some round (1 mm diameter) meshes. Blunt free-branchlets range from 1–6 mm in length. The colony is composed of an erect fan with a small perpendicular secondary fan, which is partially anastomosed to the main one, leaving some large spaces into which free twigs are projecting. Polyps are white with a thin, pale yellow ring of mostly longitudinally arranged rods below the base of the tentacles. The calyces are oval and almost flat, appearing as yellow spots with bilabiate slit-shaped apertures. They are not very crowded and are arranged in two longitudinal rows on both sides of the branches or four rows on some branches, separated by wide lines of coenenchyme. Coenenchymal sclerites are mainly purplish red, but some are yellow and a few bi-colored. They are oblong spindles (0.08–0.10 by 0.03–0.04 mm), some with a short acute end (Fig. 18A), wide blunt spindles (0.06–0.09 by

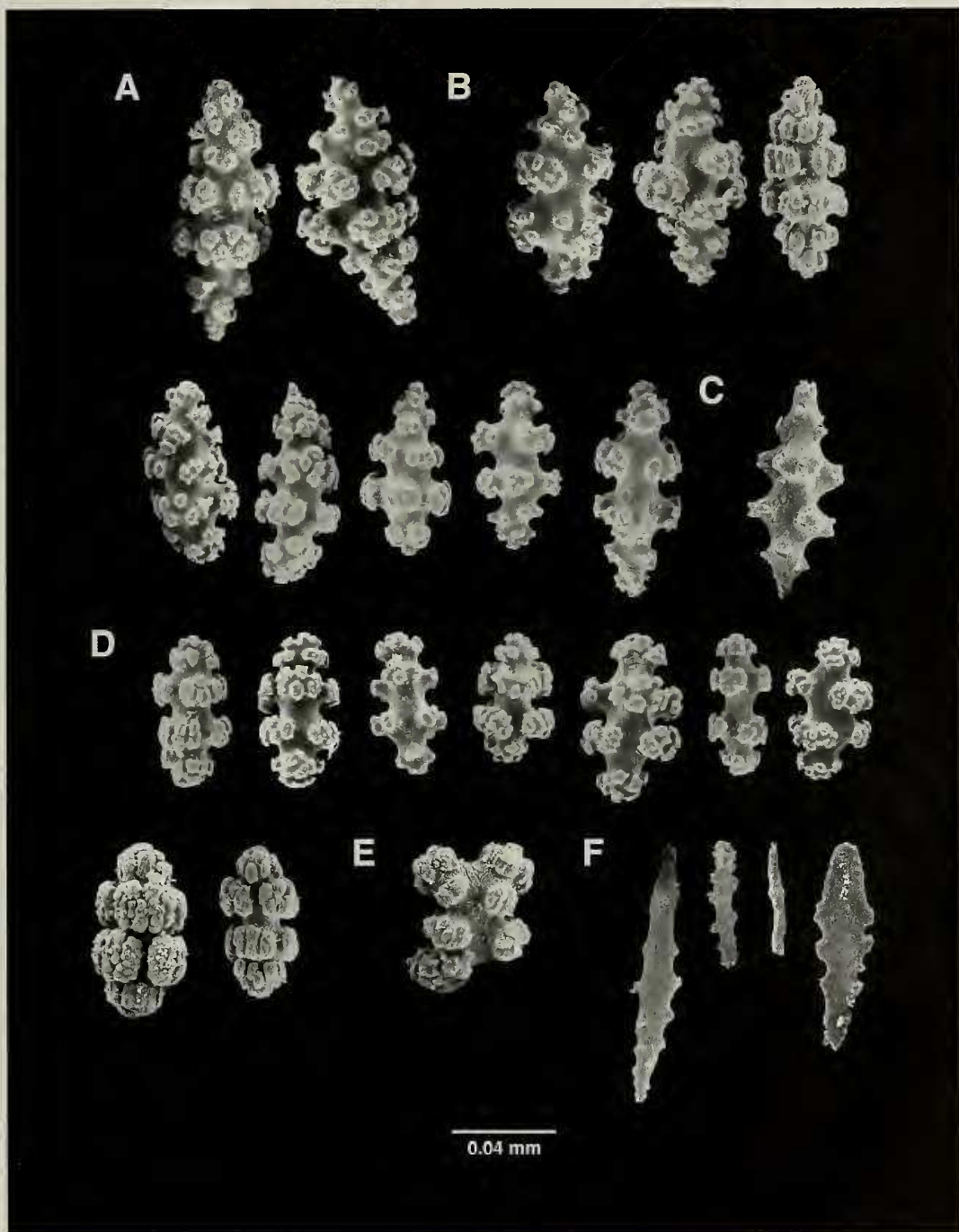


Fig. 16. *Pacifigorgia arenata* (MNHN); SEM micrographs of sclerites. A–E. Coenenchymal sclerites. F. Anthocodial sclerites. A. Spindles with acute ends. B. Blunt spindles. C. Pointed rod. D. Capstans. E. Four-radiate. F. Rods.

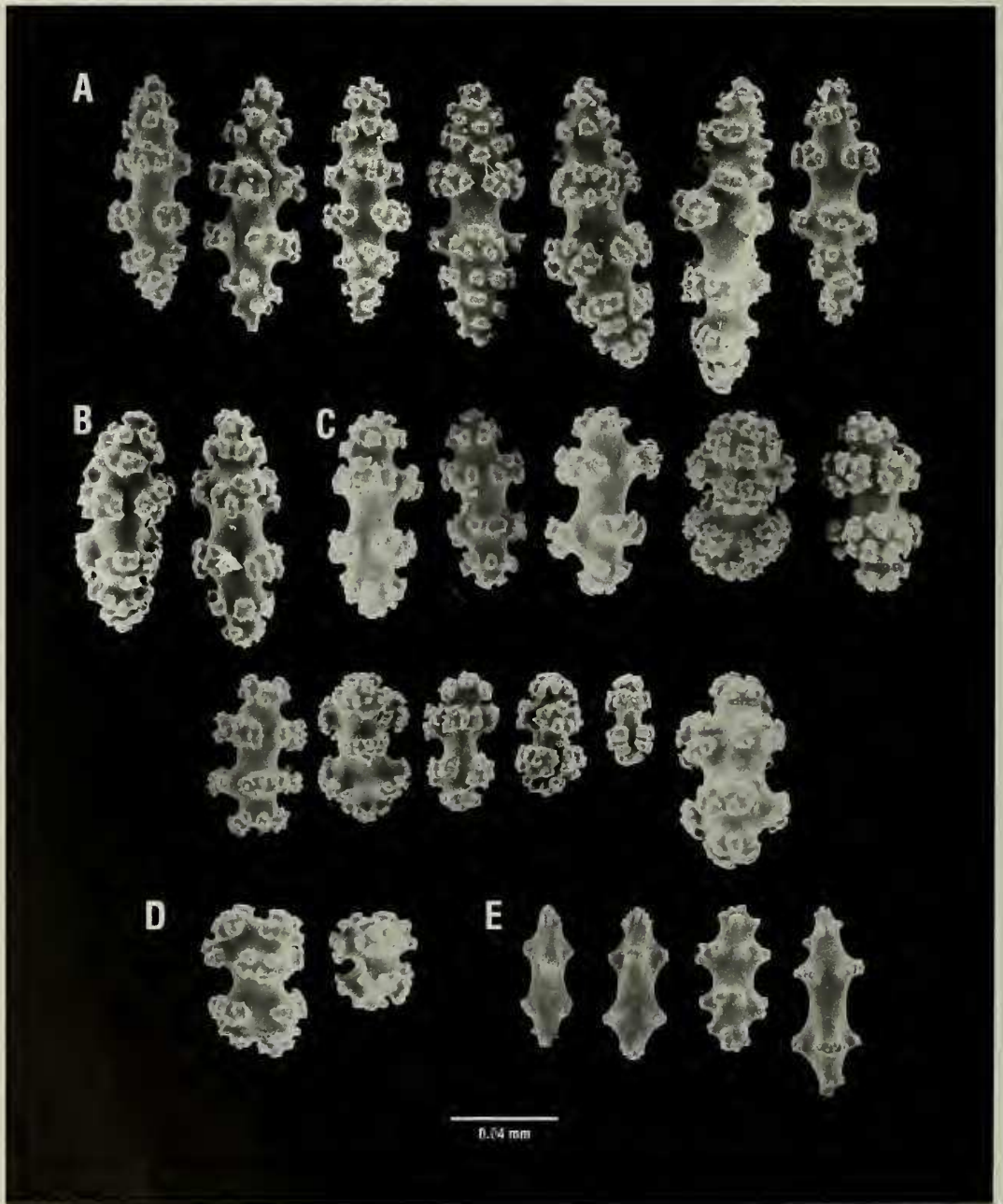


Fig. 17. *Pacifigorgia cribrum* (MNHN); SEM-micrographs of the sclerites. A–D. Coenenchymal sclerites. A. Spindles with acute ends. B. Blunt spindles. C. Capstans. D. Six-radiates. E. Rods with flat tubercles.

0.03–0.05 mm) with 2–4 whorls of warty tubercles (Fig. 18B); capstans (0.06–0.07 by 0.03–0.04 mm); some four-radiates, like crosses (0.03–0.04 by 0.02–0.03 mm) (Fig. 18D); and pink rods (0.05–0.07 by 0.02–

0.04 mm) with short projections (Fig. 18E). Anthocodial sclerites are pale yellow flat rods (0.05–0.10 by 0.01–0.02 mm), with scalloped or lobed borders and small, widely dispersed warts (Fig. 18F).

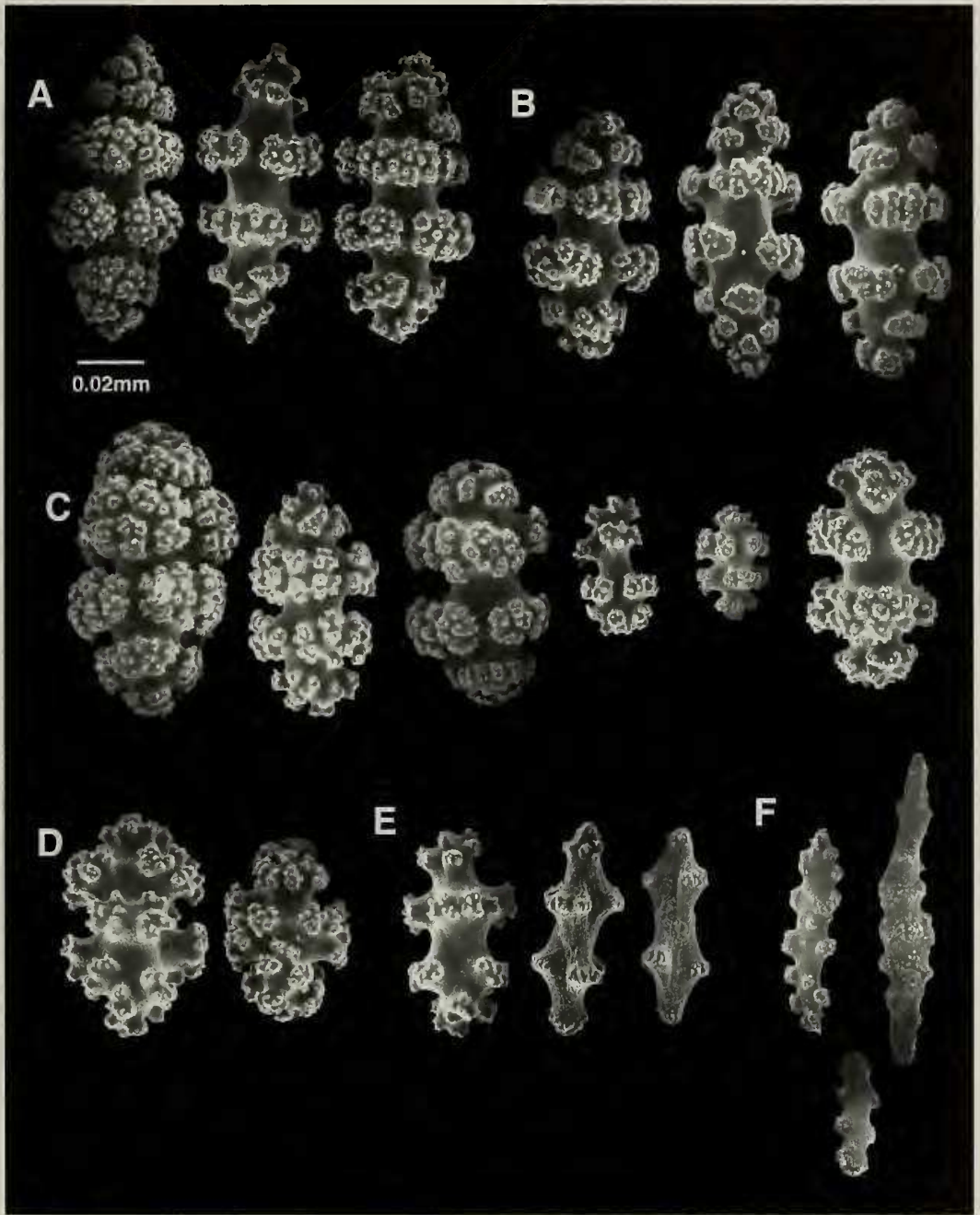


Fig. 18. *Pacifigorgia darwinii* (BM 1930.6.17.10); SEM micrographs of sclerites. A–E. Coenenchymal sclerites. F. Anthocodial sclerites. A. Spindles. B. Blunt spindles. C. Capstans. D. Four-radiate. E. Rods with short tubecles. F. Rods.

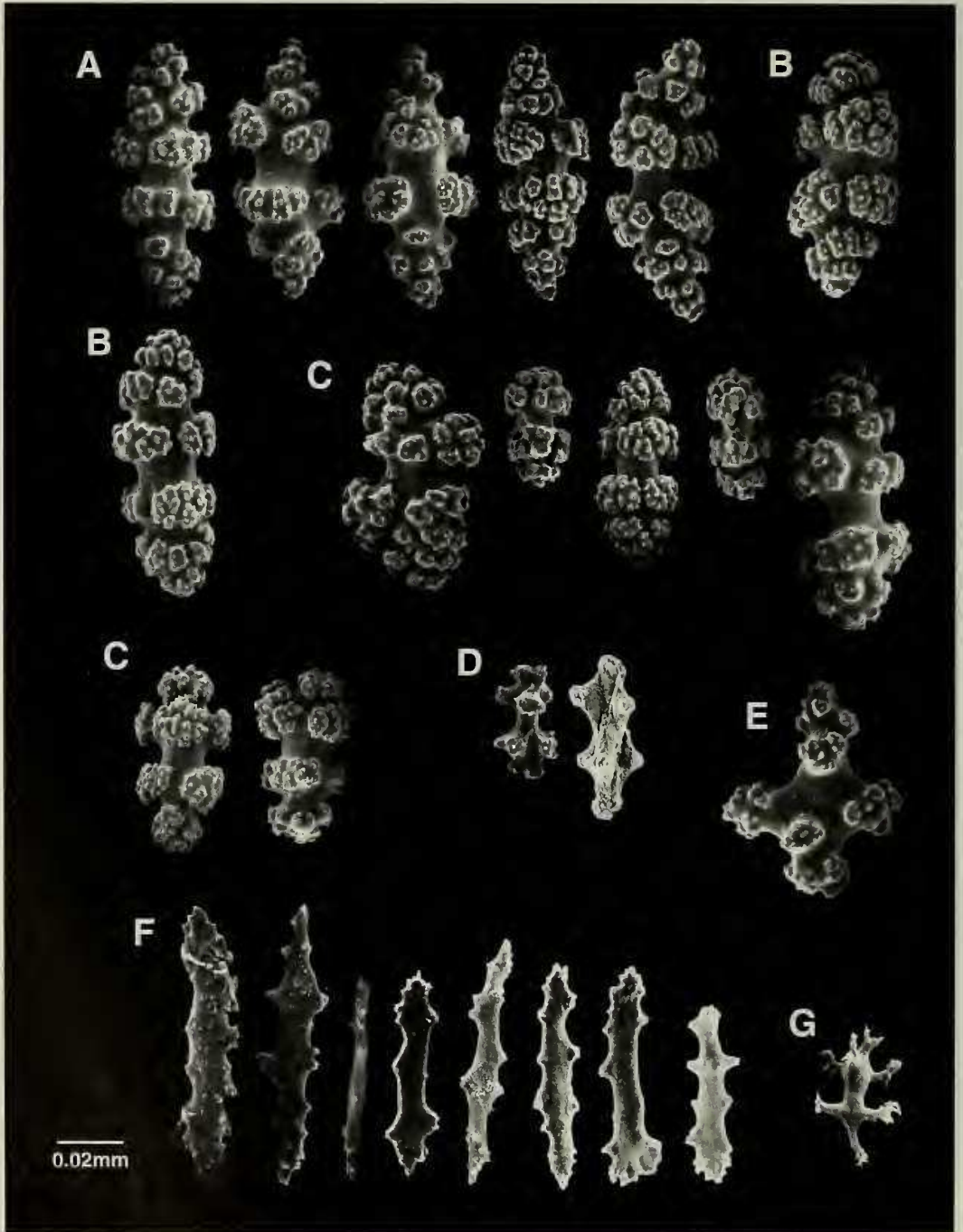


Fig 19. *Pacifigorgia elegans* (YPM 4554); SEM micrographs of sclerites. A–E. Coenenchymal sclerites. F. Anthocodial sclerites. A. Spindles with acute ends. B. Blunt spindles. C. Capstans. D. Rods with flat tubercles. E. Four-radiates. F. Flat rods. G. Spindly capstan.

Remarks.—The lectotype fits closely the characteristics of the species as described by Hickson (1928) and Stiasny (1941). Stiasny (1941) only studied a small fragment of one of the type specimens sent to him by Hickson. He described and illustrated the sclerites, except the spindles with short acute ends, described by Hickson, which he could not find. Hickson illustrated just two kinds of sclerites, and even though his drawings are not detailed, both kinds of sclerites can be recognized in *P. darwinii*, however, Hickson reported that the pointed spindles are only present in the variety *douglasii*. Hickson remarked that *Gorgonia darwinii* closely resembled his *G. tabogae* in color and form. However, he kept them apart for three reasons. First, the geographic separation: the first one was found in Galápagos and the other in Panamá. Second, the coenenchymal sclerites of *G. tabogae* are longer and thicker than the ones of *G. darwinii*. And third, the ring of anthocodial rods below the tentacles of *G. tabogae* is broad and pink and the one in *G. darwinii* is narrow and pale yellow. Stiasny (1941) did not consider these reasons valid to separate species and concluded that they were the same. While no type colonies of *G. tabogae* could be found, we were able to study a microscope slide of sclerites from Hickson's personal collection (BM 1961.2.6.163) and found them to be very different from the ones in *P. darwinii*. Although Galápagos and Panamá belong to the same faunal region, the morphological features of the sclerites, and the difference in the ring of anthocodial rods are good characters to separate these species.

Distribution.—Reported for Tagus Cove, Albemarle, Galápagos Islands (Hickson 1928), Gardner Isle, Isabella Island (10 m deep), Fernandina Island (25 m deep), and San Cristóbal Island, Galápagos Islands (Table 2).

Pacifigorgia douglasii (Hickson, 1928),
new combination
Fig. 8 A1–5, B

Gorgonia darwinii var. *douglasii* Hickson,
1928:392–393, Fig. 27.

Material examined.—*Lectotype* (here designated).—BM 1961.2.6.161, 162, sclerite microscope slide only, off Onslow Island, Galápagos Islands, 8 m in depth, 1923–24, collector, Major Douglas.

Preliminary remarks.—Hickson based his description on two specimens collected from Onslow Island by Major Douglas. The colonies appear to be missing and what remain are two microscope slides of the sclerites from Hickson's personal collection, which are designated here as the lectotype in order to ensure the identity of this species.

Description.—Hickson (1928), described one specimen, 60 × 90 mm which agreed with the characteristics of his *Gorgonia darwinii* in the thickness of the branches and differed from it in that the meshes were longer and the anastomoses were not so complete. The distribution of the polyps was more definitely in four rows. The coenenchyme was darker purple, and the calyces were white, not yellow. Coenenchymal sclerites were slender pointed spindles 0.13–0.14 mm, which varied in color; some yellow; some orange red; and some purplish red. He described a broad “collar” of pale yellow sclerites around the polyps. Hickson's other specimen was a smaller colony, 40 mm in height.

Description of the lectotype-sclerites.—The coenenchymal sclerites are mostly red, orange, pale yellow or colorless. They are blunt spindles (0.08–0.10 by 0.03–0.04 mm) (Fig. 8.1); very distinct, long spindles (0.10–0.14 by 0.03–0.04 mm) with acute ends, and two or four whorls of tubercles (Fig. 8.2); capstans (0.06–0.08 by 0.02–0.04 mm) (Fig. 8.3); and pink rods (0.06–0.09 by 0.02–0.03 mm) with acute or blunt ends and flat projections (Fig. 8.4). Anthocodial rods are flat, pale yellow (up to 0.09–0.14 by 0.01–0.02 mm), with smooth, scalloped or short lobed-borders (Fig. 8.5).

Remarks.—We could only study the sclerites of the lectotype from Hickson's personal slide collection (BM 1961.2.6.161, 162, labeled “schizotype”) because the col-



Fig. 20. *Pacifigorgia engelmanni* (YPM 388); SEM micrographs of sclerites. A–D. Coenenchymal sclerites. A. Elongated capstans. B–C. Capstans. D. Rods with flat tubercles.

onies Hickson used for his 1928 publication appear to be missing. Hickson's description of the sclerites is very incomplete, but fortunately we were able to find the spindles with acute ends that corresponds in size and shape with Hickson's "slender pointed spindles". Hickson described *Gorgonia darwinii* var. *douglasii* as being different from *G. darwinii* "in many minor particulars". However, he pointed out details that we do not consider "minor", such as longer

meshes, incomplete anastomosis, different polyp distribution, white calyces and also different sclerites. The analysis of the sclerites on the microscope slides shows important differences between this species and *P. darwinii*, and also with *P. tabogae* as Hickson pointed out. Even though Hickson gave no illustration of the colonies his description and the microscope preparations reveal enough details to indicate that *P. douglasii* is a valid species.

Distribution.—Only reported for Onslow Island, Galápagos Islands, collected from a fishing line at a depth of 8 m.

Pacifigorgia elegans

(Milne Edwards & Haime, 1857)

Figs. 6C, D, 7B, 19A–G

Rhipidogorgia elegans Milne Edwards & Haime, 1857:177.—Duchassaing & Michelotti, 1864:20, Pl. 4, Fig. 4.—Stiasny, 1951:70, Pl. 20, Fig. A.

Gorgonia hartii Verrill, 1912:391, Pl. 29, Fig. 6–6a, Pl. 30 Fig. 2, Pl. 33 Fig. 6.

Gorgonia crevauxi Stiasny, 1951:72, Pl. 22, Figs. 4–5, Pl. 20, Fig. C.

Pacifigorgia elegans.—Bayer, 1959:19, Fig. 5.—Bayer, 1961:213, Fig. 65.

Material examined.—YPM 4554, YPM 4553a, b, Maranhao, Brasil (syntypes of *Gorgonia hartii*).

Other material.—MCZ 36186, 36187, 36188, 36192, 36194, 36195, Magueripe Bay, Trinidad; USNM 58080, Isla Margarita, Venezuela; 5 specimens (no catalogue number), Playa Pedro González, Isla Margarita, Venezuela.

Preliminary remarks.—According to Bayer (1961), specimens from Toco, Trinidad, collected by Deichmann agree in form and sclerite content with the studied types from Maranhao, Brazil, classified as *Gorgonia hartii* by Verrill (1912); with *Rhipidogorgia elegans* sensu Duchassaing & Michelotti, 1864 and with a syntype of *Gorgonia crevauxi* Stiasny, studied by him. The scaphoids mentioned by Verrill (1912) were not present in the studied types, in fact the genus *Pacifigorgia* lacks that kind of sclerite; the scaphoids were obviously present in the samples as a result of contamination as Bayer (1961) pointed out. The original specimens used by Milne Edwards & Haime (1857) cannot be found. All evidence consistently points to the fact that there is only a single species of *Pacifigorgia* that occurs in the Atlantic for which the earliest name is *P. elegans* (Bayer 1961). So we feel justified in basing our descrip-

tion of the species on Verrill's specimens originally identified as *Gorgonia hartii*, and also on the other material we analyzed.

Description.—Slender, bright reddish purple fans up to 210 by 345 mm; open and evenly reticulate branching. One or several secondary fans. Thin, flat, branches (0.05–1.50 mm). Network of small, polygonal, squarish and oblong meshes from 3–7 by 2–6 mm. Stem very short, around 3 mm high. No distinct midribs, but in some colonies a thick short branch can be traced for a short distance into the fan (YPM 4553a). End-branchlets up to 10 mm long. Some short free twigs 2–4 mm long, project into large meshes. Small and slightly raised, round calyces, with a very small slit-like aperture. They are very crowded and arranged alternately in two close rows on each side of the branches. Coenenchymal sclerites are purplish red and yellow. They are spindles (0.08–0.12 by 0.03–0.04 mm) with acute ends, straight or little curved (Fig. 19A), blunt spindles (0.06–0.1 by 0.03–0.04 mm) (Fig. 19B); capstans (0.04–0.08 by 0.03–0.04 mm) of various kinds, with terminal tufts at both ends or just at one end and the other with wide tubercles (Fig. 19C); rods with flat tubercles (Fig. 16D); and four-radiate sclerites with warty ends (Fig. 19E). The anthocodial sclerites are slender, flat, pale yellow rods (0.06–0.08 by 0.01–0.02 mm) with serrated margins (Fig. 19F), and conspicuous, small, spindly capstans (0.04 by 0.02 mm) (Fig. 19G).

Variability.—The specimens from Trinidad are all composed by many secondary fans which sprout from a common thicker branch, they are all small colonies, up to 95 mm long by 100 mm wide. The colonies from Venezuela are of a purple color and are larger, reaching the size of the types.

Distribution.—From Toco, Trinidad and Tobago to Maranhao, Brazil (Bayer 1961). Specimens from Surinam were found 30 m deep.

Pacifigorgia englemanni (Horn, 1860),
new combination
Figs. 6E, F, 7C, 20A–D

Rhipidogorgia englemanni Horn, 1860:233.
(?)*Litigorgia stenobrochis* var. *englemanni*.—Verrill, 1868b.

(?)*Leptogorgia stenobrochis* var. *englemanni*.—Verrill, 1868c:394.

Gorgonia stenobrochis englemanni.—Kükenthal, 1919:773.—Kükenthal, 1924:342.

Material examined.—*Holotype*.—YPM 388, Sinaloa, Mazatlán, México; dry fragment, 15 by 17 mm, no given depth, before 1864, collector, Englemann.

Other material.—YPM 2265, Guerrero, Acapulco, México; MCZ 4042 (12), Acapulco, México; USNM 12585, 12582, México; USNM 92061, 9203, Nayarit, México; USNM 92062, Sinaloa, México; USNM 1679, 8847, 43013, Baja California; USNM 18980, Pacific coast, probably southern California.

Preliminary remarks.—The specimen used by Horn (1860) to describe this species was a large, higher than wide colony, 228 by 152 mm in size. All that seems to have remained is a small fragment, (YPM 388) 15 by 17 mm long, which was given to Verrill by the Philadelphia Academy of Sciences and deposited in the YPM.

Diagnosis.—Reddish ochre or burnt sienna colonies. Coarsely reticulated, without midribs, and with one or two lateral secondary fans. Flat thick branches (1.5–3.5 mm), in some cases rounded. Network of round, square (1–3 mm diameter) and some elongate (8–15 by 1 mm) meshes. Numerous small, low calyces distributed evenly around the branches. Coenenchymal sclerites deep red and bright yellow, warty, wide capstans (0.05–0.09 by 0.03–0.05 mm), and few blunt spindles (0.07–0.08 by 0.03–0.04 mm). Small and few, orange anthocodial rods.

Description of the holotype.—The only remains of the holotype is a small reddish ochre fragment, 15 by 17 mm long (Fig.

5D). The branches are flat and thick, 1.5–3.5 mm in diameter. They anastomose to produce a close and stout network of round or elongated meshes. The coenenchyme is thick and easily crushed. The calyces are low and small with elliptical openings, very crowded and densely packed all around the branches. Coenenchymal sclerites are deep red and bright yellow. They are elongated capstans (0.07–0.08 by 0.03–0.04 mm) with prominent tubercles at the ends (Fig. 20A); wide, compact capstans (0.05–0.09 by 0.03–0.05 mm) with warty tubercles and a short median space (Fig. 20B); wide capstans (0.05–0.07 by 0.02–0.04 mm) with warty tubercles (Fig. 20C); and small rods (0.03–0.05 by 0.01–0.03 mm) with short tubercles (Fig. 20D). Anthocodial sclerites are very small orange rods.

Remarks.—The other specimens studied were consistent with Horn's description. Notwithstanding the absence of illustrations of this species and that the holotype is a small fragment, its similarity in sclerites and morphology with other complete specimens (non-types) (see other material), convince us that *P. englemanni* is a valid species. Verrill (1864) examined Horn's specimen, and made *Rhipidogorgia englemanni* a synonym of *Rhipidogorgia stenobrochis* Valenciennes without any significant argument. He wrote that Horn's species was founded on a small and bad specimen of *R. stenobrochis* (Verrill 1864), but Horn described a large specimen "height 9 inches, width 6 inches" collected by Dr. Englemann. Probably Verrill just studied the small holotype fragment deposited in the YPM (given to him by the Philadelphia Academy of Sciences) which, however, shows clear differences with *Pacifigorgia stenobrochis*. *P. englemanni* and *P. stenobrochis* have some morphologic similarities, e.g., color, thickness of the branches, and the calyces, however, the sclerites and the meshwork are very different; the latter being much more oblong and rectangular in *P. stenobrochis*. Verrill (1868b) changed *englemanni* from a synonym of *stenobro-*

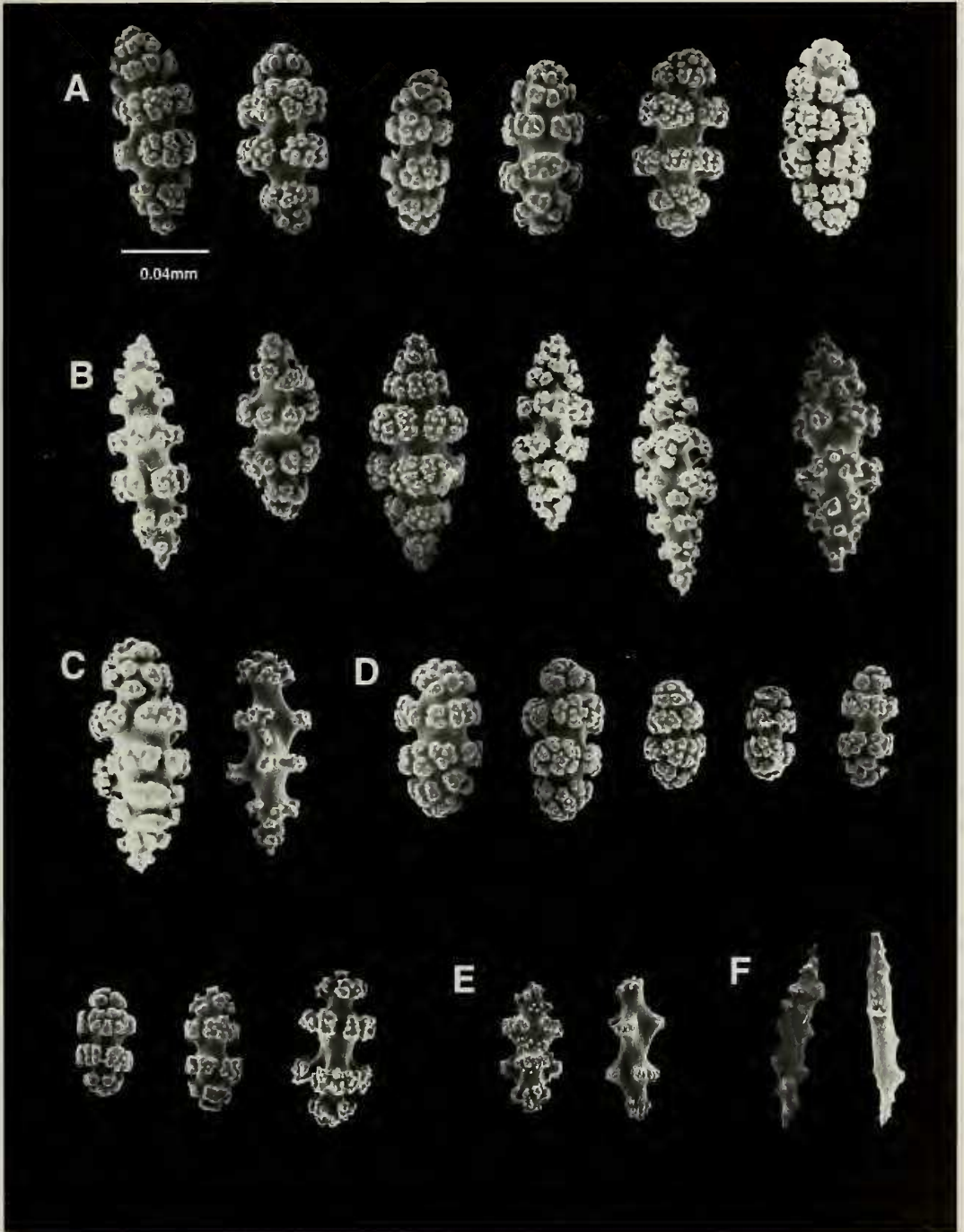


Fig. 21. *Pacifigorgia exilis* (YPM 4059a); SEM micrographs of sclerites. A-E. Coenenchymal sclerites. F. Anthocodial sclerites. A. Blunt spindles. B. Spindles with acute ends. C. Dagger spindle. D. Capstans. E. Rods with flat tubercles and warts. F. Flat rods.

chis to a variety of *stenobrochis* based on slight differences found in specimens from Panamá, but the only specimen in the YPM collection (YPM 555b) from that locality is not consistent with Verrill's description and is completely different from Horn's holotype.

Distribution.—Acapulco, Guerrero, Sinaloa, Mazatlán, Nayarit México, and Baja California (Horn 1860, Verrill 1868c) (Table 2).

Pacificorgia exilis (Verrill, 1870),
new combination

Figs. 6G, H, 7D, 21A–F

Leptogorgia pulchra var. *exilis* Verrill,
1870:550–551 (partial).

Leptogorgia pulchra Verrill, 1870:549–550
(partial).

Gorgonia pulchra exilis.—Kükenthal,
1919:773.—Kükenthal, 1924:340.—Biel-
schowsky, 1929:152.

Material examined.—*Lectotype* (here designated).—YPM 4059a, La Paz, Baja California Sur, México, dry specimen, 110 by 245 mm; depth 11–15 m, 1867–70, collector, J. Pedersen.

Paralectotype.—YPM 4059b, La Paz, Baja California Sur, México.

Other material.—YPM 4058d, 4597, 4594, MCZ 4016, La Paz, Baja California; USNM 49364, Punta Pájaro, Panamá.

Preliminary remarks.—The type material found in the YPM and the MCZ, come from the same type-locality, same depth and same collector and was identified by Verrill. However, Verrill did not designate a holotype and no illustration of the colony or the sclerites was given. We designate the specimen YPM 4059a as the lectotype of *P. exilis* in order to ensure the name's proper and consistent application in the future. Though YPM 4059b now becomes a paralectotype of *P. exilis*, the specimen is actually identifiable with *P. pulchra*.

Diagnosis.—Colonies erect, wider than high (up to 300 by 375 mm in size), frequently oblong, lobular or semicircular,

with a few or more small accessory fans radiating from the middle, upper part or the base of the main fan and growing parallel. The color is reddish orange mingled with yellow and with several hues of them. Branches rounded or slightly flattened 1.0–2.5 mm in diameter. Close network of square and oblong meshes around 0.5–3 mm wide, or meshes completely filled with coenenchyme. Wide holdfast and no stem. Several flat short midribs from 3–6 mm in diameter. Free-branchlets quite short, up to 2 mm long. Calyces small, rounded and slightly raised, very crowded (0.25–0.5 mm diameter) in four close rows around the branches. Coenenchymal sclerites deep red and bright yellow, and some bi-colored. Blunt spindles (0.07–0.09 by 0.03–0.04 mm); acute spindles (0.10–0.11 by 0.03–0.05 mm); dagger spindles (0.08–0.10 by 0.03–0.04 mm); and capstans (0.05–0.07 by 0.03–0.04 mm). Yellow, oblong, anthocodial rods (0.07–0.12 by 0.01–0.02 mm) with smooth or spiny borders.

Description of the lectotype.—The colony is an erect, wider than high, reddish orange, dry specimen, 110 mm long, 245 mm wide, composed of a main lobed fan and small accessory fan (Fig. 6A, B). The colony rises directly from a strong holdfast, and radiates into four short, flat midribs (3–6 mm thick) extending irregularly along the lateral borders of the colony, parallel to the substratum. The branches are slightly flattened (1.0–2.5 mm thick). They regularly anastomose to form a network of close, square and oblong meshes (0.5–3.0 mm diameter), some of which are totally filled with coenenchyme. The free-branchlets are blunt and quite short (mostly less than 2 mm). The small secondary fan arises from a branch projecting perpendicular to the main fan that immediately bends upwards forming another fan parallel to the main fan. The calyces are small (0.25–0.50 mm diameter), rounded and slightly raised with bilabiate apertures. They are mostly arranged in four close rows around the branches, very crowded, but more distant or

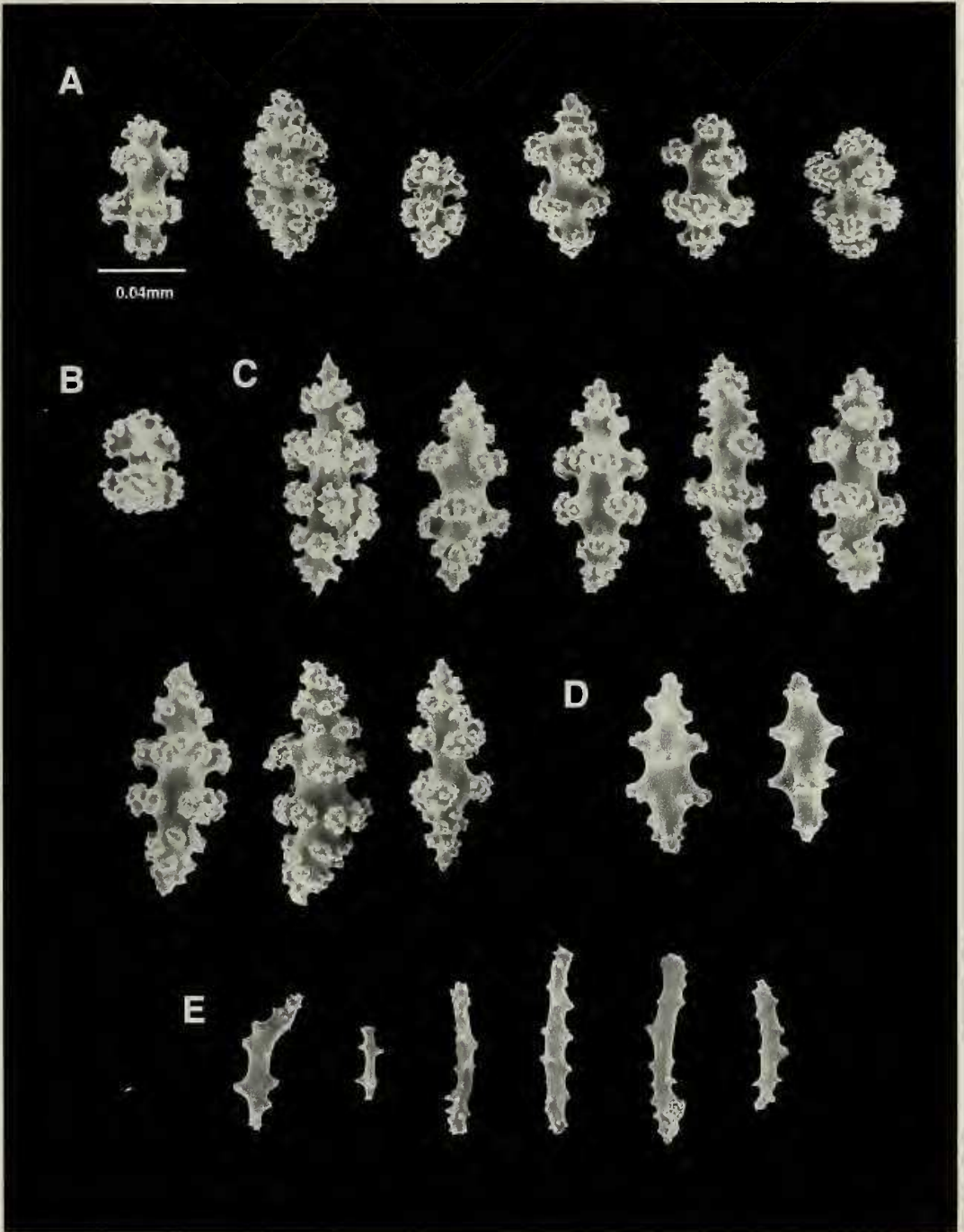


Fig. 22. *Pacifigorgia eximia* (YPM 1550a); SEM micrographs of sclerites. A–D. Coenenchymal sclerites. E. Anthocodial sclerites. A–B. Capstans. C. Long spindles with acute ends. D. Pointed rods with flat tubercles. E. Flat rods.

absent on the midribs. Distinct yellow and orange longitudinal grooves extend along the midribs. Coenenchymal sclerites are deep red, bright yellow and some bi-colored. They are blunt spindles (0.07–0.09 by 0.03–0.04 mm) (Fig. 21A); spindles (0.10–0.11 by 0.03–0.04 mm) with sharp or acute warty ends (Fig. 21B); long dagger spindles (0.085–0.01 by 0.038–0.04 mm) (Fig. 21C); capstans (0.04–0.07 by 0.03–0.04 mm) (Fig. 21D); and long rods (0.06–0.07 by 0.03–0.035) with tubercles and warty tufts (Fig. 21E). Anthocodial sclerites are yellow oblong rods (0.08–0.12 by 0.01–0.02 mm), with smooth or spiny margins (Fig. 21F).

Remarks.—Verrill (1870) described *Leptogorgia pulchra* var. *exilis* as a slender variety of *Leptogorgia pulchra*, which he assigned as the typical form of the species. Verrill's characterization of *L. pulchra* var. *exilis* is confusing because he indicated that the fan was "loosely reticulated, with larger, squarish or oblong meshes", with the meshes 5 to 6 mm wide by 6–18 mm high, but no comparative lengths were given for *L. pulchra*. Even though the size and shape of the meshes are very subjective, definitively *P. exilis* is thicker and has a closer meshwork, than *P. pulchra*. It is also clear that in *P. exilis*, the calyces are much less prominent and smaller than in *P. pulchra* and additionally, they are arranged differently. In *P. pulchra*, they are in two rows around the branches, contrasting with the four-row arrangement of *P. exilis*. Verrill (1870) pointed out that very little variation exists regarding the sclerite content among these species. But after the examination of Verrill's types, and other material, we found that the anthocodial rods are consistently orange, larger and wider in *P. pulchra* and pale yellow and more slender in *P. exilis*, and also that the spindles are longer in *P. exilis*. According to Verrill (1870) one large specimen in his collection showed characteristics of both varieties, the specimen YPM 4055 (marked "transition") showed thicker branches and closer calyces at the

base of the colony. However, we studied sclerites from different parts of the colony, and found that they were always the same kinds (see *P. pulchra*).

Distribution.—Gulf of California, Baja California Sur, La Paz, México (Verrill 1870), collected, between 11–15 m deep by divers; and Punta Pájaro, Panamá (Table 2).

Pacifigorgia eximia (Verrill, 1868c)
Figs. 9A–B, 10A, 22A–E

Litigorgia eximia Verrill, 1868b.—Verrill, 1869b:422.

Leptogorgia eximia Verrill, 1868c:390–391, Pl. 5, Fig. 20, Pl. 4, Fig. 2.—Verrill, 1869b:422.

Gorgonia eximia.—Bielschowsky, 1918:39.—Kükenthal, 1919:773.—Kükenthal, 1924:341.—Not Hickson, 1928:386–387.—Bielschowsky, 1929:146.—Not Stiasny, 1943:74–76, Fig. 10.

(?)*Pacifigorgia eximia.*—Prahl et al., 1986:14, Fig. 1.

Material examined.—*Lectotype* (here designated).—YPM 1550a, dry specimen, 230 by 230 mm, Pearl Islands, Gulf of Panamá, Panamá, depth 11–15 m, 1866–67, collector, F.H. Bradley.

Paralectotypes.—YPM 1550b, c, YPM 8746; MCZ 4040, MCZ 4041, Pearl Islands, Gulf of Panamá, Panamá.

Other material.—USNM 44214, 49381, Golfo de Nicoya, Costa Rica; USNM 33613, 33612, 52320, Pearl Islands, Panamá; MCZ, no catalogue number, Colombia; UCR 926 Caño Island, Costa Rica.

Preliminary remarks.—Verrill did not designate a holotype for *P. eximia*. In order to establish the identity of this species, we chose YPM 1550a as the lectotype. YPM 1550a is the best complete specimen found in the type collection. YPM 8746 and 1550c are fragments and YPM 1550b is an almost complete colony but broken at the base. It was not possible to determine which was the figured specimen.

Diagnosis.—Erect colonies, rounded, deep red or light burnt orange up to 170–

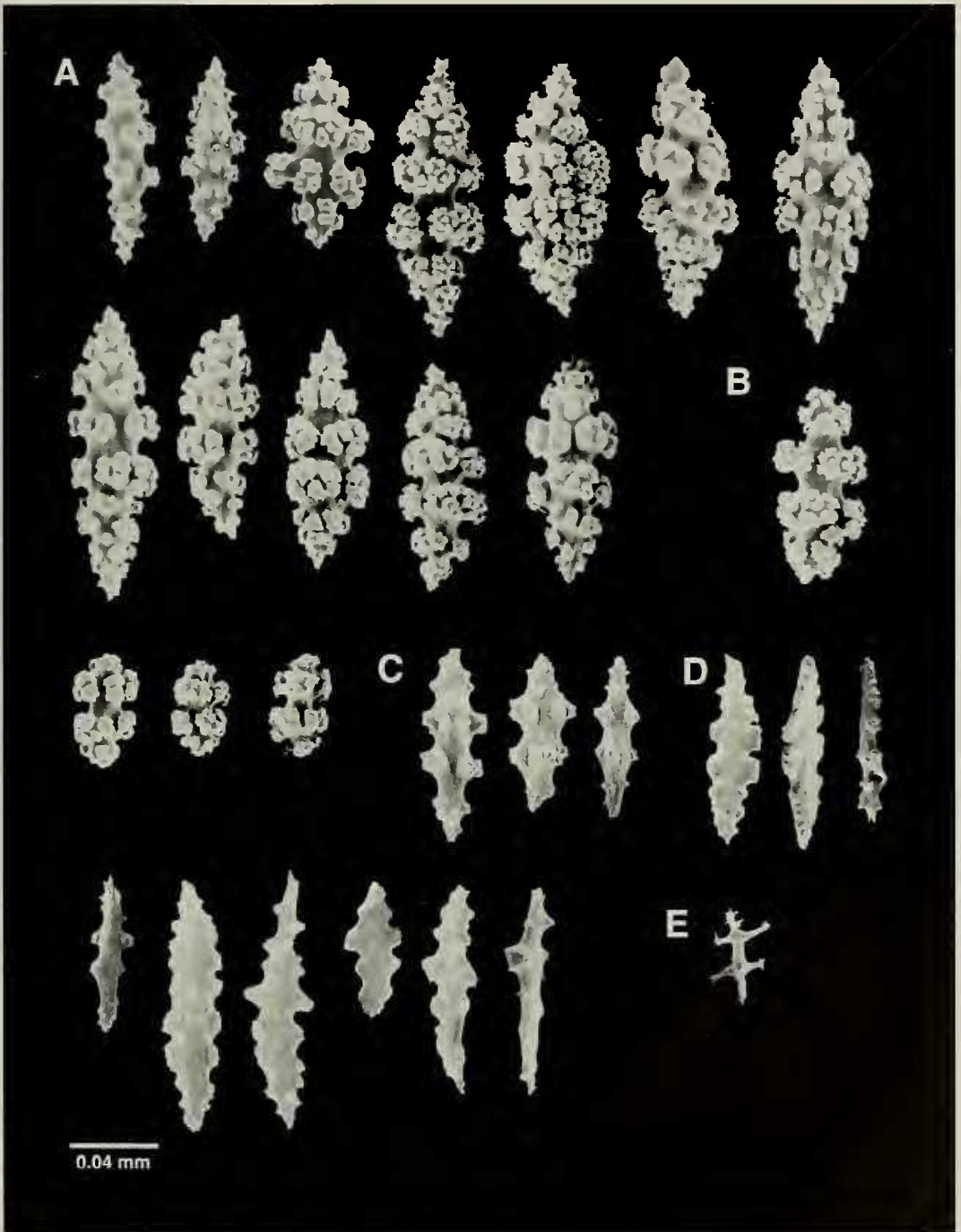


Fig. 23. *Pacifigorgia gracilis* (YPM 8745); SEM micrographs of sclerites. A–C. Coenenchymal sclerites. D–E. Anthocodial sclerites. A. Long spindles with acute ends. B. Capstans. C. Rods with flat tubercles. D. Flat rods. E. Spindly capstan.

230 by 170–230 mm in size. Fan of a single frond or with two or three secondary fans. Open reticulated network of square and oblong meshes from 1–30 by 2–3 mm. Meshwork very irregular and incomplete in some cases. Free twigs up to 20 mm long. No distinct midribs present. Branches from 1.5 mm diameter at the tips to 5 mm at the base. Smooth surface of slightly raised calyces, arranged evenly around the branches. Coenenchymal sclerites mostly bright red with a few light yellow. Long spindles (0.10–0.15 by 0.04–0.06 mm) with acute ends; blunt spindles (0.08–0.11 by 0.04–0.05 mm); and capstans. Anthocodial sclerites light yellow rods (0.06–0.12 by 0.01–0.03 mm) with scalloped or lobed margins and few distant warts.

Description of the lectotype.—The specimen is an erect, deep red, rounded, reticulate colony, 230 mm long, 230 mm wide and composed mostly of cylindrical, slender branches arising from a circular holdfast (30 mm diameter). The branches are uniform in size (around 1.5 mm in diameter), except near the base where they are thicker (3–5 mm in diameter). Some of the meshes at the base of the colony are totally filled by coenenchyme. There is a rather short stem and no distinct midribs. The branches anastomose to form an open network, with meshes of irregular size and shape; squares (1–2 mm) and short or oblong rectangles (2–30 by 1–3 mm). Two branches project perpendicular to the main fan and immediately bend upwards and form two small secondary fans parallel to the primary fan. Other branches just bend freely to form short twisted growths. Many free-twigs project into the large meshes, they are so abundant that the colony loses its reticular appearance; they are up to 22 mm long, but most are short, 1–5 mm. The free-branchlets range from 5–30 mm long. The calyces are small, rounded and slightly raised, and are uniformly arranged around the branches. The sclerites are predominantly bright red with a few, light yellow, small capstans. Coenenchymal sclerites are long spindles

(0.10–0.15 by 0.04–0.05 mm) with 2–4 whorls of tubercles and acute oblong ends with many small warts (Fig. 22A); elongated capstans (0.06–0.07 by 0.03–0.04 mm) (Fig. 22B); short capstans (0.04–0.05 by 0.03–0.04 mm) (Fig. 22C); and long pointed rods (0.07–0.08 by 0.03–0.035 mm) (Fig. 22D). Anthocodial sclerites are slender, light yellow rods (0.07–0.10 by 0.01–0.02 mm) with scalloped margins, and others (0.06–0.08 by 0.02–0.03 mm) with a few distant warts and with lobed borders (Fig. 22E).

Remarks.—The studied types match both the description and the illustrations of *P. eximia* of Verrill (1868b). Hickson (1928), with some hesitation, identified three specimens from San José Island and two from Rey Island, Bay Panamá as *Gorgonia eximia*. Later, Stiasny (1943) studied a fragment from Rey Island and published some illustrations of the sclerites. Even though Stiasny's drawings are not detailed, the descriptions of the sclerites of his specimens are consistent with those of Hickson. We had the opportunity to study the sclerites of Hickson's specimens from his personal microscope slide collection, and found spindles, 0.16–0.20 mm long, slightly curved, with 8 to 12 warty whorls, that are not present in Verrill's material. Consequently, the species described by Stiasny and Hickson was not *P. eximia*. This material needs re-examination. *Pacificorgia eximia* was reported from Málaga Bay, Colombia (Prahl et al. 1986), but some differences in the size and shape of several sclerites reported by them, make it difficult to determine which species they were dealing with.

Distribution.—Pearl Islands, Panamá (Verrill 1868a); collected between 11–15 m deep by divers; Golfo de Nicoya (11–15 m), Caño Island, Costa Rica, 25 m deep, and Colombia. Although Hickson (1928) pointed out that the type specimens of *P. eximia* came from La Paz, Nicaragua, there are neither specimens nor data to verify this (Table 2).

Pacificorgia gracilis (Kükenthal, 1924)

Figs. 9C–D, 10B, 23A–E

Leptogorgia tenuis Verrill, 1870:551–552: [not *L. tenuis* Verrill, 1863:8 = *Leptogorgia virgulata* (Lamarck, 1815)].

Gorgonia tenuis.—Bielschowsky, 1918: 39.—Kükenthal, 1919:773.—Hickson, 1928:384–386, figures 21, 25.—Bielschowsky, 1929:154.

Gorgonia gracilis.—Kükenthal, 1924:341.

Material examined.—*Holotype*.—YPM 8745 (= identified by Verrill, 1870, as a new species, *Leptogorgia tenuis*), dry specimen, 83 by 44 mm, La Paz, Baja California Sur, México, depth 7–11 m, 1867–70, collector, J. Pedersen.

Paratype.—YPM 4062, data as for the holotype.

Preliminary remarks.—A collection of specimens from the Bay of New York (Atlantic Ocean), was described by Verrill (1863) as *Leptogorgia tenuis*. He found the specimens to be similar to *L. virgulata* (Lamarck, 1815), but decided that they belonged to the new species. Later (Verrill 1870), he used the same name (*Leptogorgia tenuis*) for a new species from La Paz, Baja California, and subsequently the name was changed to *Gorgonia tenuis* (Bielschowsky, 1918). The material from the Bay of New York was very different from *L. tenuis*. Because the new name *L. tenuis* was applied to specimens later found to be *L. virgulata*, the name was actually unavailable for Verrill to be used for the new species from La Paz. For this reason, Kükenthal (1924) created the new name *Gorgonia gracilis*, although without explanation.

Verrill described the new species (*L. tenuis*) with one specimen from La Paz, Baja California, collected by J. Pedersen and pointed out that the specimen was found on the base of a colony of *Eugorgia nobilis* var. *excelsa*. We found two specimens from the same locality, same collector, identified by Verrill, with one labeled type YPM 8745, and no label on the other, YPM 4062. Even though no illustration was given, we

believe these were the specimens that Verrill used for his proposed new species *Leptogorgia tenuis*.

Diagnosis.—Irregular delicate, deep red colonies, with a loose and incomplete network of asymmetric squarish and oblong meshes from 10–20 by 2–7 mm wide. Long free-twigs up to 10 mm in length, with bud-like tips. No distinct midrib present. Branches 0.5–0.7 mm in thickness. Long, blunt free-branchlets from 3–10 mm. A warty surface of prominent, relatively large and distant calyces, in alternating rows around the branches. Coenenchymal sclerites bright red or deep yellow, and some bi-colored. Wide and stout spindles (0.09–0.14 by 0.03–0.05 mm) with long, acute ends. Red and orange anthocodial rods (0.04–12 by 0.01–0.03 mm) with scalloped or blunt lobed margins.

Description of the holotype.—The specimen is a small, 83 by 44 mm, delicate, ragged colony (Fig. 9C). It is uniformly deep red, and forms an irregular fan composed of slender branches round in cross section, that are mostly uniform in size (around 0.5–0.7 mm in thickness). Many branches do not anastomose, so a very loose network of irregular square or oblong meshes (10–20 by 2–7 mm) is formed. The numerous long free-twigs are up to 10 mm long, and the long free-branchlets 10–15 mm in length; both with conspicuous bud-like wide tips. Due to multiple free-branching, the colony loses its reticular appearance. There are no midribs. The calyces are prominent, relatively large cones (around 0.34 mm in diameter) arranged in two or four alternating, irregular rows along the branches, and grouped in two or four at the tips (Fig. 7B). They are not crowded, but produce a lumpy surface. Coenenchymal sclerites are bright red and deep yellow, in almost equal numbers, and some bi-colored. They are spindles (0.09–0.14 by 0.03–0.06 mm) with 3–4 whorls of tubercles, a marked waist, and long acute warty ends, or they can be slender, with disperse warts not arranged in defined whorls (Fig. 23A).

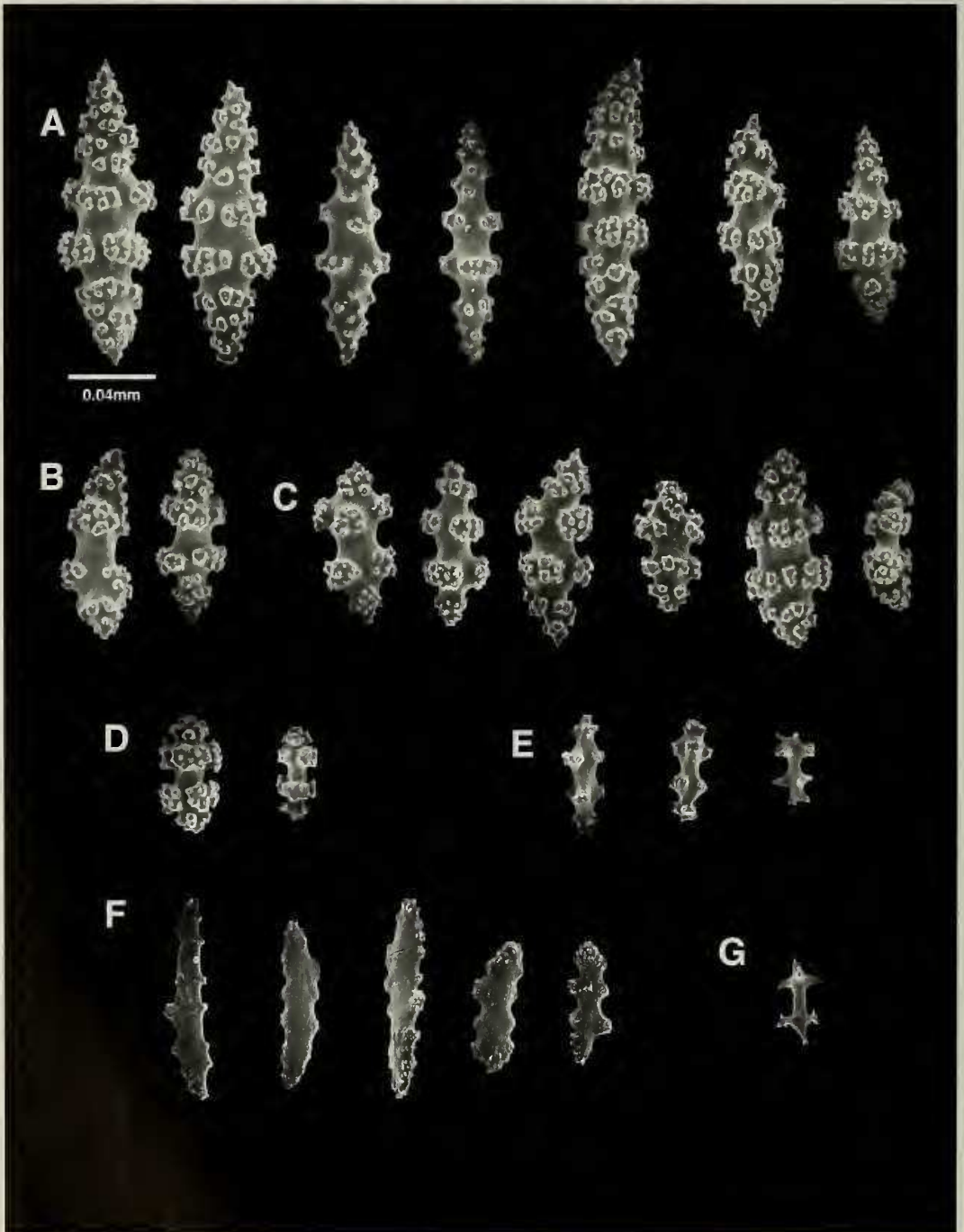


Fig. 24. *Pacifigorgia irene* (USNM 33611); SEM micrographs of sclerites. A–E. Coenenchymal sclerites. F–G. Anthocodial sclerites. A. Long spindles with acute ends. B. Dagger spindle. C. Elongated capstans. D. Capstans. E. Rods with short tubercles. F. Flat rods. G. Spindly capstans.

There are also small capstans (0.04–0.05 by 0.02–0.03 mm) (Fig. 23B); and oblong rods (0.07–0.08 by 0.03 mm) with short tubercles and pointed ends (Fig. 23C). Anthocodial sclerites are red and orange rods (0.07–0.12 by 0.01–0.03 mm), slender, with acute ends and short-lobed margins, broader forms (0.06–0.12 by 0.02–0.03 mm) with scalloped or blunt lobed borders (Fig. 23D), and spindly capstans (around 0.045 by 0.03 mm) (Fig. 23E).

Distribution.—La Paz, Baja California Sur, México and San José Island, Panamá (Verrill 1870) (Table 2). The specimen described by Verrill (1870) was found on the base of a colony of *Eugorgia nobilis* var. *excelsa*, from 7–11 m deep. Later, three specimens from San José Island, Panamá were collected from 45 m deep and identified by Hickson (1928), but his identification needs to be confirmed.

Pacifigorgia irene Bayer, 1951

Figs. 9E–F, 10C, 24A–G

Litigorgia adamsii Verrill, 1868b (partial).

Leptogorgia adamsii Verrill, 1868c:391–392, Pl. 4, Fig. 4; Pl. 5, Fig. 5 (partial).—Verrill, 1869b:421 (partial).

(?)*Gorgonia media*.—Bielschowsky, 1918:38.

Gorgonia adamsii—Kükenthal, 1924:339 (partial).—Hickson, 1928:380–383, Fig. 22 (partial).

Gorgonia media.—Galtsoff, 1950:27.

Pacifigorgia irene Bayer, 1951:94–96.

Material examined.—*Holotype.*—USNM 49365, Punta Pajarón, Panamá.

Paratype.—USNM 33611, Gulf of Nicoya, Costa Rica.

Other material.—UCR 506, 935, 937, Caño Island; UCR 493, 488, Dominical; UCR 476, Punta Uvita; UCR 413, Punta Mala; UCR 906, Murciélago Islands, UCR 938 (3 fragments) Sámara Bay, Costa Rica.

Diagnosis.—Large, erect, broad colonies (up to 800 mm long by 900 mm wide), rusty purplish red with yellow ochre up to the margins. Finely and regularly reticulate.

Slender branches (0.5–0.7 mm thick). Network of small, squarish meshes, up to 2 mm in diameter, crossed by several very stout, flattened midribs up to the edge of the fan. Very short end-branchlets (less than 1 mm). Small, slightly raised and very crowded bilabiate calyces distributed evenly along the outer edges of the branches, producing a rough warty surface. Coenenchymal sclerites mostly red, some pale yellow and colorless. Long acute spindles (0.09–0.14 by 0.02–0.04 mm) (Fig. 24A); elongated, irregular capstans (0.05–0.09 by 0.02–0.04 mm) (Fig. 24B); small capstans (0.04–0.06 by 0.02–0.03 mm) (Fig. 24C), and rods with short and flat tubercles (0.04–0.06 by 0.015–0.02 mm) (Fig. 24D). Anthocodial sclerites are flat rods with broadly scalloped edges (0.06–0.09 by 0.01–0.02 mm) (Fig. 20E), and small spindly capstans (0.03–0.04 by 0.018–0.02 mm) (Fig. 24F). The anthocodial sclerites are usually colorless, but a few may be pink (Fig. 24G).

Description of the holotype.—See Bayer 1951:94–96.

Remarks.—The differences between *P. irene* and *P. adamsii* were analyzed by Bayer (1951) and discussed under *P. adamsii* above. The *P. adamsii* specimens described by Kükenthal (1924) and Hickson (1928), even though incomplete colonies, fit *P. irene* better than *P. adamsii*. Bielschowsky (1918), in her key to the species of *Gorgonia*, separated a species with strong midribs from two other species (*P. adamsii* and *P. rutila*) and referred it to *Gorgonia media* Verrill. This species was identified as *Gorgonia media* Verrill (sensu Bielschowsky 1918) in Galtsoff (1950) and later described as *P. irene* by Bayer (1951).

Distribution.—Punta Pajarón, Panamá; Gulf of Nicoya, Costa Rica (Bayer 1961). This species is found from 15 to 33 m deep, on rocky bottoms in Santa Elena Peninsula, Sámara Bay, Caño Island and Osa Peninsula, Costa Rica (pers. obs.) (Table 2).

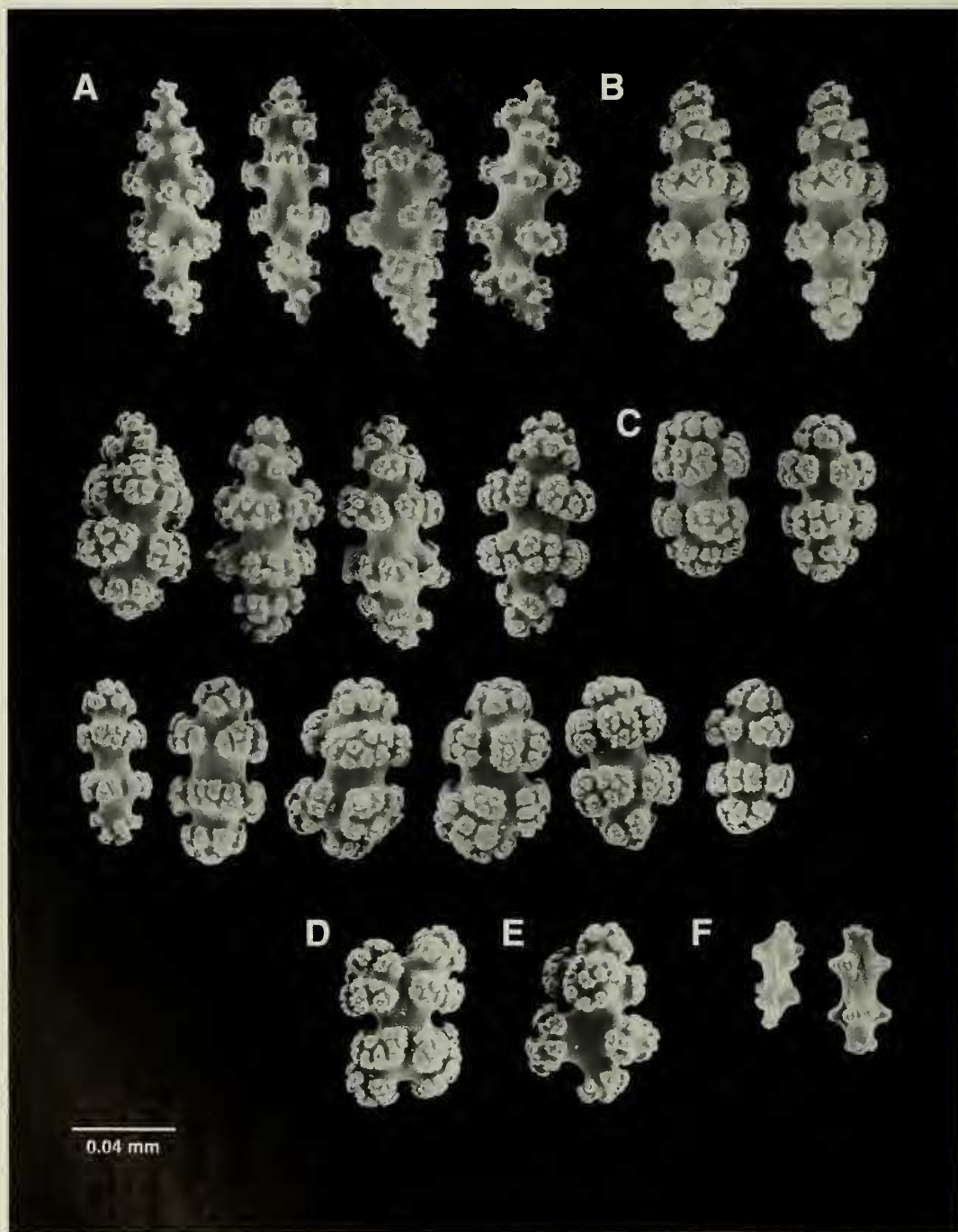


Fig. 25. *Pacifigorgia media* (MCZ 4035); SEM micrographs of sclerites. A–E. Coenchymal sclerites. F. Anthocodial sclerites. A. Spindles with acute ends. B. Blunt spindles. C. Capstans. D. Four-radiate. E. Eight-radiate. F. Rods with flat tubercles.

Pacificorgia media (Verrill, 1864)

Figs. 9G, H, 10D, 25A–E

Rhipidogorgia media Verrill, 1864:33 (partial).*Rhipidogorgia agassizii* Verrill, 1864:32 (partial).*Gorgonia media* Verrill, 1866:327.—Biel-schowsky, 1918:38.—Kükenthal, 1919:773.—Kükenthal, 1924:338–339.—Biel-schowsky, 1929:147.*Litigorgia media* Verrill, 1868a.—Verrill, 1868b:389–390.—Verrill, 1869b:422.*Leptogorgia media*.—Verrill, 1868c:389–390.—Verrill, 1869b:422.(?)*Pacificorgia media*.—Prahl et al., 1986:16, Fig. 3.*Pacificorgia media*.—Bayer & Macintyre, 2001:318 (mineralogy).*Material examined*.—*Lectotype* (here designated).—MCZ 4035 (185), dry, 150 by 60 mm, Acapulco, México, no given depth, collector, A. Agassiz.*Paralectotypes*.—MCZ 4035c, Acapulco, México.*Other material*.—YPM 955, 956a, b, 4061, 4060a, c, USNM 1678 (2), 57905, 57907, 33728, Baja California Sur, Cape San Lucas; CASIZ 097771, 097773, Baja California Sur, Peñón Las Ánimas, México; MCZ 4036 (7), Oaxaca coast, México; MCZ 36263a, b, Panamá.*Preliminary remarks*.—Verrill's original description (1864) of *Gorgonia media* was based on specimens from Acapulco collected by A. Agassiz and D. B. Vanbrunt. No specimens collected by Vanbrunt were found having original labels or identification. The only specimens found collected by Agassiz from Acapulco were two small colonies, under MCZ 4035 (185 original label). Three colonies were entered in the MCZ catalog in 1862, labeled as types and identified by Verrill. These specimens fit Verrill's (1864) very brief descriptions of both *G. media*, and also *G. agassizii*, but the size of the meshes [intermediate between *G. stenobrochis* and *G. agassizii* (Verrill 1864)] leads us to be-lieve that the specimens well fit *Leptogorgia media*, as corroborated by Verrill's further description (1868b, c). Verrill properly described this species in 1868b, 1868c, with specimens from Acapulco and other localities, leaving out the specimens collected by Vanbrunt. Even though Verrill used the type series deposited in the YPM from La Paz, Baja California, collected by J. Xantus for his later description, the specimens MCZ 4035 are the only ones that proved to belong to the original series from Acapulco (1864). MCZ 4035 was selected as the lectotype, in order to ensure the proper use of this name.*Diagnosis*.—Colonies higher than wide, red or brownish, mingled with yellow, up to 385 by 310 mm in size, with a single or several lobed fans. Flat stem less than 2.5 mm high, or totally reduced, very distinct midribs in large colonies, from 4–14 mm in diameter. Short, compressed, round branches from 1.0–2.5 mm in diameter forming an open network of mainly square and rounded meshes (2–5 mm), some oblong up to 15 by 1 mm. Free-branchlets 1–5 mm long, and free twigs mostly less than 3 mm in length. Small calyces, scarcely raised, sometimes yellow, in 2–4 longitudinal rows along the branch sides, and separated at the thicker branches. Coenenchymal sclerites deep red and yellow, some bicolored. Wide, blunt spindles (0.07–0.10 by 0.04–0.05 mm), long, wide spindles (0.10–0.12 by 0.03–0.04 mm) with acute ends. Pale orange, slender anthocodial rods (0.07–0.11 by 0.01–0.03 mm), with smooth or short-lobed margins.*Description of the lectotype*.—The specimen is a small 150 by 60 mm colony, red, mingled with yellow and with yellow calyces. The holdfast is broken off, and the colony is composed of two small fans, with two short midribs (8–5 mm thick), subdividing and diminishing in diameter close to the periphery (Fig. 9G, H). A few calyces and some thin longitudinal grooves can be seen on the midribs. Branches are slightly

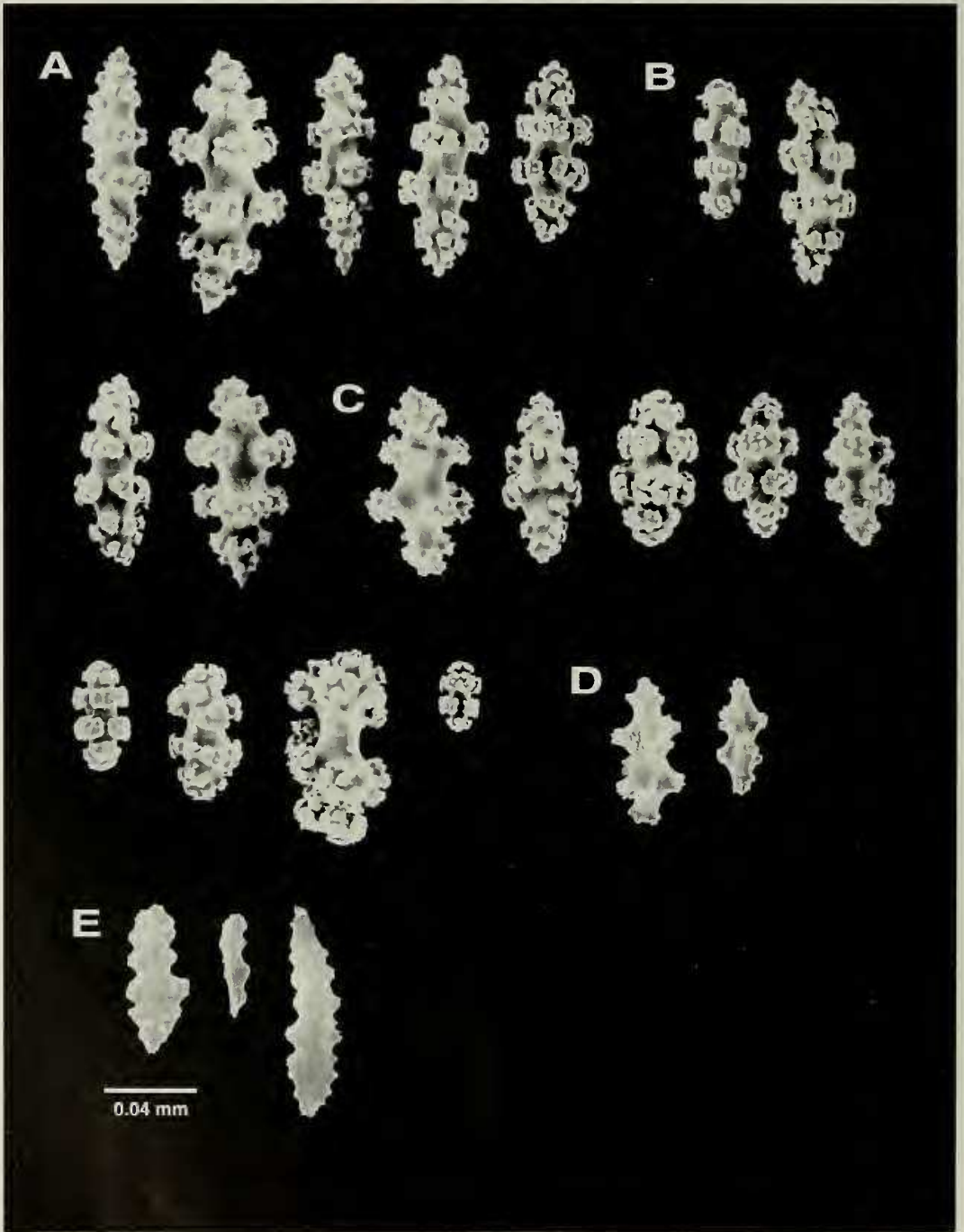


Fig. 26. *Pacifigorgia pulchra* (YPM 4058b); SEM micrographs of sclerites. A–D. Coenenchymal sclerites. E. Anthocodial sclerites. A. Long spindles with acute ends. B. Blunt spindles. C. Capstans. D. Rods with flat tubercles. E. Flat rods.

compressed, from 1–2.5 mm in diameter, regularly anastomosing to form an open network of mostly square (2–5 mm), circular (less than 1 mm diameter), and some oblong (up to 15 by 1.5 mm long) meshes. Some isolated meshes are filled in with coenenchyme, some others are small and rounded, and look like small holes along the midribs. The free-branchlets are short, usually less than 5 mm long, but can reach 8 mm. The calyces are rather small, low mounds with oval, yellow, bilabiate openings (around 0.12–0.20 mm in diameter), arranged in two or four longitudinal rows along each side of the branches, separated by bands of coenenchyme, and more distant or absent on the midribs. Coenenchymal sclerites are deep red, bright yellow, and some bi-colored. They are spindles (0.10–0.13 by 0.04–0.05 mm) with long acute warty ends (sometimes bent), and with 2 complete whorls of tubercles (Fig. 25A); wide blunt spindles of 4 whorls (0.08–0.10 by 0.04–0.05 mm) with warty tubercles and long warty ends (Fig. 25B); capstans (0.05–0.07 by 0.03–0.04 mm) broad and warty (Fig. 25C); some warty four-radiates (around 0.07 by 0.05 mm) (Fig. 25D); conspicuous eight-radiates (around 0.08 by 0.05 mm) (Fig. 25E); and rods (0.04–0.05 by 0.02–0.03 mm) with flat tubercles and blunt ends (Fig. 25F). No anthocodial sclerites could be seen in the sample.

Variability.—Large colonies can be composed of many secondary fans, up to 7, which radiate from the thick midribs. In the small specimens, there are several thicker branches radiating from a minute stem, but they are not as distinct as the midribs in the big colonies. They have thick holdfasts with numerous, thin longitudinal grooves of alternating red and yellow sclerites, producing sinuous figures in some places. There are also very few calyces. The calyces in the majority of colonies are less prominent and the yellow rings are more blended than in the lectotype.

Remarks.—The specimens described by Prah et al. (1986) for Gorgona Island, Co-

lombia, have larger sclerites, the mesh is predominantly rectangular, and the illustrations given are not clear enough to determine whether the species is *P. media* or not. The general morphology of *P. media* resembles *P. agassizii*, but in the latter species the mesh is smaller. In small colonies of *P. media*, the midribs are not well developed and are similar to *P. exilis*, but the distribution, shape and size of the calyces are different from *P. exilis* and the sclerites are also inconsistent with the latter.

Distribution.—La Paz, Gulf of California, Baja California Sur, Acapulco, México; San Salvador, Corinto, Nicaragua (Verrill 1868a) (Table 2). It was reported for Gorgona Island, Colombia living in high-energy zones on rocky substrates by Prah et al. (1986), but it is not clear if the species was correctly identified.

Pacifigorgia pulchra (Verrill, 1870),
new combination

Figs. 11A, B, 12B, 26A–E

Leptogorgia pulchra Verrill, 1870:549–550
(partial).

Leptogorgia pulchra var. *exilis* Verrill,
1870:550–551 (partial).

Gorgonia pulchra.—Bielschowsky, 1918:
38.—Kükenthal, 1919:773.—Kükenthal,
1924:340.—Hickson, 1928:383–384, Fig.
23.—Bielschowsky, 1929:151.—Galtsoff,
1950:27.

Material examined.—*Lectotype* (here designated).—YPM 4058b, dry specimen, 160 by 223 mm, Baja California Sur, La Paz, México, 12–14 m in depth, 1867–70, collector, J. Pedersen.

Paralectotypes.—YPM 4055b, 4058d, MCZ 4016, USNM 33612, Baja California Sur, La Paz, México.

Other material.—YPM 4597, 4059b, La Paz, Baja California.

Preliminary remarks.—Verrill (1870) described *Leptogorgia pulchra* with specimens from La Paz, Baja California, but did not designate a holotype. The details of the sclerites were vague, and no illustrations

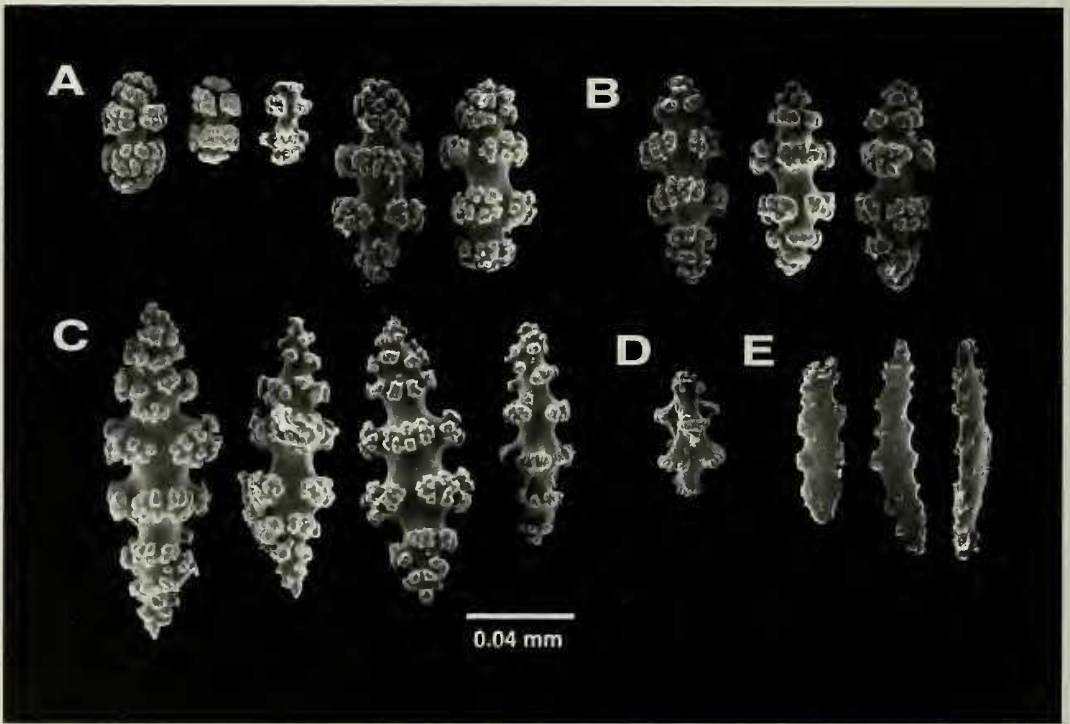


Fig. 27. *Pacifigorgia rutila* (YPM 2266); SEM micrographs of sclerites. A–D. Coenenchymal sclerites. E. Anthocodial sclerites. A. Capstans. B. Blunt spindles. C. Spindles with acute ends. D. Rods with flat tubercles. E. Flat rods.

were given. The type specimens found in the various museums included specimens of other species. In order to establish the correct identity of this species, YPM 4058b was chosen as the lectotype. This specimen shows very well the characteristics given by Verrill (1870).

Diagnosis.—Erect, semicircular, reddish orange colonies, up to 160 by 380 mm in size, single or compound fans. Thin, slender branches, with square cross section (up to 1.0 mm in diameter). Open networks of mostly angular and rectangular meshes (1–20 by 2–20 mm). Short stem from up to 4.0 mm high and indistinct midribs present. Clavate free-branchlets, from 3–8 mm, free-twigs up to 5 mm long. Two rows of round, prominent calyces along each side of the branches; very crowded, and producing a warty surface. Coenenchymal sclerites deep red, bright yellow and some bi-colored. Blunt spindles (0.05–0.07 by 0.03–0.04

mm); long and wide spindles (0.08–0.11 by 0.03–0.05 mm) with acute ends. Anthocodial rods orange, oblong and wide (0.07–0.14 by 0.02–0.03 mm), with serrated and lobed margins. Some slender thorny needles also present in the anthocodia.

Description of the lectotype.—The specimen is reddish orange, mingled with yellow. It is 160 by 223 mm, wider than high, and composed of several fans (Fig. 11C). It has a short stem (3.5 mm high) that bifurcates, close to the round holdfast, into several short midribs (3–4 mm thick), which subdivide rapidly and merge into the fan. The branches are mostly square in cross section, and slender throughout (1.0–1.5 mm in thickness). They regularly anastomose to form an open network of mostly rounded (1–3 mm diameter) and rectangular (4–20 by 2–20 mm) meshes. Some short free-twigs (up to 5 mm) project into the large meshes, and the free-branchlets are

clavate and range from 3–8 mm in length. The secondary fans are formed from thick branches of the primary fan that project perpendicular and then grow parallel to the main fan. The calyces are rounded and prominent (0.50–0.75 mm diameter), with bilabiate apertures, and are arranged alternately in two rows along each side of the branches giving them their square form (Fig. 11B). Calyces are mostly very crowded, but more distant or absent on the thicker branches and the midribs. Distinct yellow and orange longitudinal grooves are well marked along the midribs. Coenenchymal sclerites are deep red or bright yellow, and some are bi-colored. They are long spindles (0.08–0.11 by 0.03–0.05 mm) with 4–6 whorls of tubercles and acute warty ends (Fig. 26A); blunt spindles (0.05–0.07 by 0.03–0.04 mm) with 2–4 whorls of tubercles and warty ends (Fig. 26B); capstans (0.04–0.05 by 0.02–0.03 mm) (Fig. 26C); and rods (0.05–0.06 by 0.02–0.03 mm) with flat tubercles (Fig. 26D). Anthocodial sclerites are wide, oblong orange rods (0.08–0.14 by 0.02–0.03 mm) with margins serrated, or lobed rods (0.07–0.08 by 0.02–0.03 mm) (Fig. 26E), and a few slender, thorny needles (0.09 by 0.01 mm).

Remarks.—The specimens of *P. pulchra* were included with *P. exilis* in various collections, which were originally described as a slender variety of *P. pulchra* (see *P. exilis*). The colony YPM 4059b was labeled as type of the slender variety (*exilis*), but it fits *P. pulchra*. Contrary to YPM 4058d and MCZ 4016, though both becoming, paralectotypes of *P. pulchra*, show all the characteristics of *P. exilis*. The specimen USNM 49364 was identified as *P. pulchra* but it fits *P. exilis* instead.

Distribution.—Gulf of California, La Paz, Baja California Sur, México (Verrill 1870) collected between 11–15 m deep by divers. According to Hickson (1928) he had a specimen found off Taboga, Panamá, but no colonies from Panamá have been located.

Pacifigorgia rutila (Verrill, 1868c),
new combination

Figs. 11C, D, 12B, 27A–E

Rhipidogorgia agassizii Verrill, 1864:32
(partial).

Litigorgia adamsii var. *rutila* Verrill, 1868b.

Leptogorgia rutila Verrill, 1868c:392–393.

Gorgonia rutila.—Bielschowsky, 1918:38.—Kükenthal, 1919:773.—Kükenthal, 1924:339–340.—Bielschowsky, 1929:146.

Pacifigorgia cribrum.—Bayer & Macintyre, 2001:318 (mineralogy).

Material examined.—*Lectotype* (here designated) YPM 2266, dry specimen, 123 by 220 mm, Guerrero St. Acapulco, México, no depth given, prior 1860, collector, A. Agassiz 1859–1860 (Received by the YPM on exchange from MCZ).

Paralectotypes.—YPM 1706; MCZ 7061; MCZ 4034; MCZ 4011 (7); Acapulco, México.

Other material.—MCZ 7010, 4012 (5), 32264, Acapulco, México; MCZ 4033, 4034, Oxaca, México; MCZ 4014, Cape San Lucas, Baja California; MCZ 4015, Mazatlán.

Preliminary remarks.—Verrill described this species with a series of specimens from Acapulco, and without a designation of a holotype. Because of the confusion in the identification of this species mentioned above (under *P. adamsii*), we chose the colony YPM 2266, which is also the figured specimen (Verrill 1868c, Pl. 5, Fig. 13) as the lectotype of *P. rutila*.

Diagnosis.—Erect, broader than high colonies of a conspicuous burnt orange color, up to 250 by 300 mm in size. Slender, square branches from 1.0–1.5 mm thick. Fine network of tiny round and oblong meshes (0.25–1.00 mm diameter, 1.0–1.5 high by 1–2 mm wide). Very short stem (up to 7 mm in length) and no distinct midribs. Quite small, blunt free-branchlets, up to 3 mm. Two rows of rounded, bi-lobed and prominent calyces along each side of the branches, very crowded. Pink and light or-

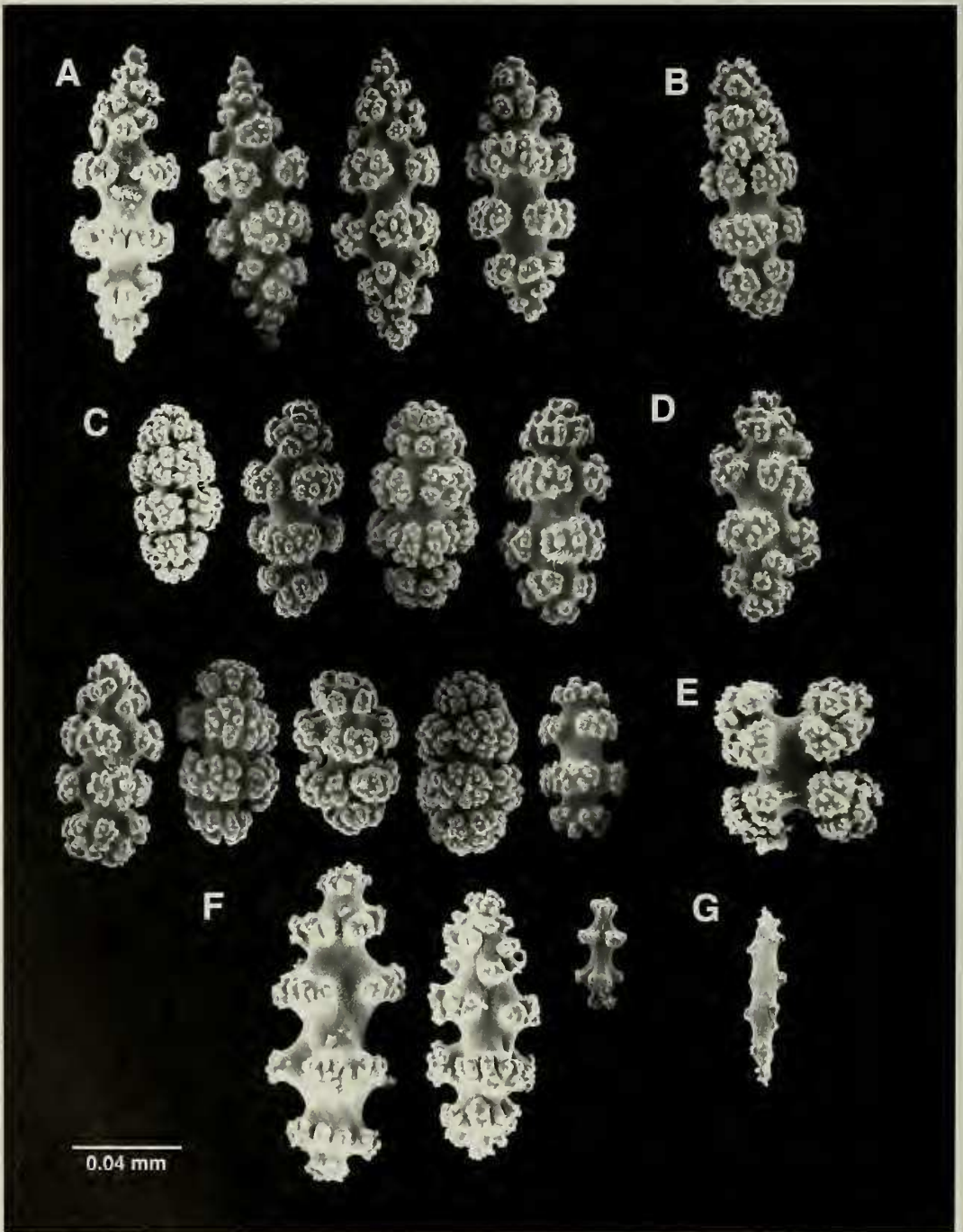


Fig. 28. *Pacifigorgia stenobrochis* (MNHN OCT.S.2000.03); SEM micrographs of sclerites. A–F. Coenenchymal sclerites. G. Anthocodial sclerites. A. Spindles with acute ends. B. Dagger spindles. C. Blunt spindles. D. Capstans. E. Four-radiates. F. Rods with flat tubercles and warts. G. Flat rods.

ange coenenchymal sclerites. Long spindles (0.09–0.14 by 0.03–0.05 mm), with acute warty ends; blunt spindles (0.08–0.09 by 0.03–0.04 mm); and abundant capstans (0.03 to 0.05 by 0.02–0.03 mm). Anthocodial sclerites, long dull orange rods (0.09–0.11 by 0.01–0.02 mm), with scalloped margins.

Description of the lectotype.—The specimen is a flat, wider than high colony, 123 by 220 mm in size, of a characteristic burnt orange color. It has a very short stem (5 mm high); except for some short thicker branches, which can be traced radiating horizontally at the base of the fan, no distinct midribs are present. Branches are square in cross section, and slender throughout (1.0–1.5 mm thick). They regularly anastomose to form a fine network of tiny, round (0.25–1.00 mm diameter) and oblong (1.0–1.5 by 1–2 mm long) meshes; some of them are totally filled by coenenchyme, especially at the basal part of the colony. Free-branchlets are quite small with blunt enlarged tips, less than 3 mm long. Calyces are round and prominent, about 0.75 mm diameter with broad, bilabiate apertures. They are arranged closely in two rows along each side of the branches, and are very crowded, producing a warty surface. Coenenchymal sclerites are pink and light orange. They are blunt spindles (0.08–0.09 by 0.03–0.04 mm) with 4 whorls of tubercles and warty ends (Fig. 27B); long spindles (0.09–0.14 by 0.03–0.05 mm) with acute warty ends and with 4–6 whorls of warty tubercles (Fig. 27C); capstans (0.04–0.05 by 0.02–0.03 mm) with broad tubercles (Fig. 27A). Also short rods with flat tubercles, or elongated rods with shorter tubercles and warts (Fig. 27D). Anthocodial sclerites are long dull orange rods (0.09–0.11 by 0.01–0.02 mm), with acute, slightly warty ends and margins scalloped or serrated (Fig. 27E).

Remarks.—Although no illustration of the sclerites was provided by Verrill (1868c) the characterization of them is very similar to our observation. Even though the largest spindle with acute ends found by

Verrill was 0.156 by 0.048 mm, and the largest we measured was 0.14 by 0.05 mm long, the size of the sclerites in general is quite consistent. *P. rutila* and *P. agassizii* are somewhat similar and have been confused with one another. The meshes are almost the same size, but *P. agassizii* has very distinct midribs, smaller calyces with bright yellow sclerites, and thinner branches. Additionally, the sclerites are totally different and the color of the colony of *P. rutila* is very characteristic (Table 1). Similarity to *P. cribrum* was discussed above (under *P. adamsii*) (Table 1).

Distribution.—La Paz, Baja California; Acapulco, México (Verrill 1868a) (Table 2).

Pacifigorgia stenobrochis
(Valenciennes, 1846)

Figs. 11E, F, 12C, 28A–G

Gorgonia stenobrochis Valenciennes, 1846, Pl. 12, Fig. 1, 1a.—Bielschowsky, 1918: 39.—Kükenthal, 1919:773.—Kükenthal, 1924:341–342.—Hickson, 1928:387–390.—Bielschowsky, 1929:155.—Galtsoff, 1950:27, Fig. 16.—Stiasny, 1951: 32.

Rhipidogorgia stenobrachis.—Valenciennes, 1855:13.—Milne Edwards and Haime, 1857:176.—Verrill, 1864:32.

Gorgonia stenobrochis.—Verrill, 1868a: 414.

Gorgonia (Rhipidogorgia) stenobrochis.—Verrill, 1866:327.

Gorgonia (Eugorgia) stenobrochis.—Verrill, 1868a:414.

Litigorgia stenobrochis.—Verrill, 1868b.

Leptogorgia stenobrochis.—Verrill, 1868c: 393–394.—Verrill, 1869b:421.

Pacifigorgia stenobrochis (new combination).—Bayer, 1951:94.

Material examined.—*Holotype.*—MNHN OCT.S.2000.03, dry specimen, 345 by 275 mm, New Zealand (certainly an error), no depth given, 1839, collector, Voyage de la Vénus, Capitaine Du Petit-Thouars.

Other material.—MCZ 4044 (15), 18135 (2), MNHN OCT.S.2000.04, Panamá; YPM

555, 556, 1711, 4615, 5637, Panamá; USNM 49729, USNM 49366, USNM 92060, USNM 18980, North Pacific Ocean; UCR 831, Cabo Blanco; UCR 771, UCR 498, Caño Island.

Preliminary remarks.—Valenciennes (1846) named this species (as *Gorgonia stenobrochis*) using a specimen collected in the Voyage de la Vénus expedition (1836–1839) from New Zealand. As it was mentioned above, the locality of collection was a mistake. Valenciennes changed the name “*stenobrochis*”, to “*stenobraxis*”, in 1855, which is considered, according to the Code (1999–2000:42, article 33), an unjustified emendation. Verrill (1868c) pointed out that the name was misspelled and fixed the original *stenobrochis*. Apart from the illustrations of this species in Valenciennes’ (1846) publication, there is no description. Despite the doubtful origin of the specimen MNHN OCT.S.2000.03, it constitutes the holotype by monotypy. Bayer (1951) designated *Gorgonia stenobrochis* Valenciennes as the type species for the genus *Pacificogorgia*.

Diagnosis.—Colonies large up to 190–580 mm in size, stiff, dark purple, dark yellow, or brown, sometimes intermingled. Open reticulate, with a single fan or subdivided in 2–5 lateral fans. Stem very short or absent, holdfast wide and strong. Branches mostly compressed, around 2–5 mm thick, and nearly round in cross section at the tips. No distinct midribs present. Network of long, oblong, or rectangular meshes around 10–35 by 1–4 mm in size. Free-branchlets up to 30 mm long. Low, oval calyces, distributed on both sides of the branches, not very crowded, leaving the branches with a smooth texture. Coenenchymal sclerites pink, light yellow or bi-colored. Coenenchymal sclerites basically: blunt spindles (0.08–0.12 by 0.04–0.04 mm), long spindles (0.10–0.12 by 0.03–0.04 mm) with acute ends; wide dagger spindles (0.08–0.11 by 0.037–0.04 mm); wide warty capstans (0.03–0.06 by 0.02–0.04 mm); and four-radiates (0.04–0.07 by

0.02–0.04). Pale yellow anthocodial rods (0.03–0.06 by 0.01–0.02 mm) with edges scalloped, or slightly lobed.

Description of the holotype.—The specimen is a large, 345 by 275 mm, stiff, open reticulate, pale violet colony, with a thick holdfast (32 mm in diameter). The branches spring directly from the holdfast or form a very short, stout stem. No distinct midribs are present, but some thick branches can be followed for various distances into the fan. Branches are compressed in the plane of the fan (2–5 mm thick), and some, especially at the tips, are nearly round in cross section. The branches anastomose to form a quite regular network of long, oblong or rectangular meshes (10–35 by 1–4 mm wide) (Fig. 11E, F). The colony is formed of three fans. The free-branchlets are distinctly long, from 10–30 mm in length, with rounded tips. A few, very short, free-twigs are present (1.0–1.5 mm). The calyces are oval, low mounds with a slit-like aperture, distributed uniformly on all sides of the branches; less crowded on the thick lower branches. Coenenchymal sclerites are pink, pale yellow and colorless. They are long spindles (0.10–0.12 by 0.038–0.04 mm) with 2–3 whorls of tubercles and warty elongated ends (Fig. 28A). Also wide dagger spindles (0.08–0.11 by 0.037–0.04 mm) (Fig. 28B); blunt spindles (0.08–0.01 by 0.035–0.04 mm) with 3–4 whorls of warty tubercles and warty tufts (Fig. 28C); and broad capstans (0.04–0.07 by 0.02–0.04 mm) with wide, warty tubercles (Fig. 28D). There are four-radiates with warty tubercles at the ends (Fig. 28E). Also, short (around 0.04 by 0.02 mm) rods with 2 whorls of flat tubercles, or elongated (0.09–0.12 by 0.3–0.4 mm) with 2–4 whorls of tubercles and warty tufts at the ends (Fig. 28F). Anthocodial sclerites are pale yellow rods (0.03–0.07 by 0.01–0.02 mm), with scalloped or slightly lobed edges (Fig. 28G).

Variability.—The color of the colonies varies from dark purple, violet, yellow ochre, and both dark purple and yellow ochre in the same colony (pers. obs.). Small

colonies are formed by one fan and the branches are more rounded (UCR 771). Some small colonies from Panamá (YPM 556) form blade-like fans with very few anastomosis. The sclerites vary in the dominance of a color (from pink to light yellow), and also some variation in shapes was observed, e.g., the presence of more spindles with sharp ends in some samples. Hickson (1928) pointed out that there is a great variability between colonies of this species, such as color and sclerite dominance. This variability persists even if the specimens are from very similar environments and collected at one spot.

Remarks.—The taxonomic characters of the original Valenciennes holotype (MNHN OCT.S.2000.03) are very consistent with those of MNHN OCT.S.2000.04 identified by Milne Edwards & Haime (1857). The descriptions given by Verrill (1868c) and Hickson (1928) of this species, even though accurate, were not illustrated. It seems that the only illustration was given by Valenciennes (1846, Fig. 12, figure 1, 1a). According to Verrill (1868c) the reported site of collection of the Valenciennes' specimen, New Zealand, was a mistake (see above, under *P. arenata*), the colony was probably collected in Acapulco or Mazatlán, which were reported later (data in museum catalogues) as collecting sites of this species. This species presents a certain similarity with *P. englemanni*, which was discussed above.

Distribution.—Acapulco, México; San Salvador; Corinto, Nicaragua; Pearl Islands, Panamá; Zorritos, Perú; Puntarenas, Costa Rica (Verrill 1868c). The colonies from Pearl Islands and Zorritos were collected between 11 and 15 m deep (Verrill 1868c) (Table 2). This species is found 15–30 m deep in Caño Island, Murciélago Archipelago, Cabo Blanco, Sámara Bay and Punta Matapalo, Costa Rica (pers. obs.).

Pacifigorgia tabogae (Hickson, 1928),
new combination
Fig. 13 A1–4, B1

Gorgonia tabogae Hickson, 1928:393, Pl. 4, Figs. 6, 28.—Stiasny, 1943:76–77.

Material examined.—*Holotype.*—*Gorgonia tabogae*, BM 1961.2.6. 163, microscope slide of sclerites, Isla Taboga, Panamá.

Other material.—USNM 44215, Gulf of Nicoya, Costa Rica.

Preliminary remarks.—Hickson described *Gorgonia tabogae* from three fragments of a colony found off Taboga Island in 1915. The only material that we could locate from the holotype, is a microscope slide of the sclerites (BM 1961.2.6.163) made by Hickson. These sclerites are very distinct from the ones found in the other species, so we believe the species is valid.

Diagnosis (Deduced from Hickson's description and microscope slide).—Dark purple fans. Irregular, open network of rounded, or polygonal meshes. No evidence of distinct midribs. Calyces slightly raised as low mounds. Polyps with a broad ring of pale pink anthocodial rods below the tentacles. Largest coenenchymal sclerites, purple, spindles with acute ends, up to 0.16 by 0.06 mm in size. Numerous blunt spindles up to 0.13 by 0.06 mm in size, some yellow, some purple and some bi-colored. Capstans up to 0.09 by 0.06 mm, and conspicuous four radiates ("a few peculiar quadruplets" Hickson, 1928).

Description of the sclerites.—The coenenchymal sclerites of the holotype are large, bright yellow, and bi-colored. They are blunt spindles (0.09–0.13 by 0.05–0.06 mm) (Fig. 13A.1); spindles with acute ends (0.10–0.16 by 0.05–0.06 mm) (Fig. 13A.2); conspicuous four radiates (around 0.09 by 0.09 mm) (Fig. 13A.3); and capstans (0.07–0.09 by 0.04–0.06 mm) (Fig. 13A.4). Anthocodial sclerites are flat, pale orange rods (0.05–0.08 by 0.01–0.02 mm) (Fig. 13B.1), with smooth, scalloped or slightly lobed borders.

Remarks.—According to Hickson (1928), the holotype was a dark purple fan similar to *P. darwinii*. The differences between *P. tabogae*, *P. darwinii* and *P. douglasii* were discussed above. We found a fragment of a colony (85 mm by 35 mm)

from Costa Rica in the USNM (USNM 44215), identified by Deichmann as *G. tabogae*. The sclerites of this colony are very similar in shape and color (a little paler) to the ones in the holotype slide, but they are considerably smaller (spindles with acute ends, up to 0.11 mm; blunt spindles, up to 0.08 mm). Additionally, the anthocodial rods of USNM 44215 are longer, up to 0.09 mm. A more complete description of *P. tabogae* will have to wait until fresh material of this species is found.

Distribution.—Only reported for Taboga Island, Panamá (Hickson 1928).

Final Remarks

The previous information known, regarding habitat, depth, abundance and geographic location of the eastern Pacific octocorals was inadequate or nonexistent. Mainly because the samples were collected by pearl divers, or fishing gear or by dredging, never by the scientists themselves and also, in some cases, enthusiasts, who acquired the octocorals as souvenirs and donated them to museums. However, we cannot overlook that information, and consequently, the geographic distribution of the species of *Pacifigorgia* presented in Table 2 is based on the literature and personal observation. Of the 18 species described, only one is found in the Atlantic Ocean, and this is between Trinidad and Brazil. Nine species were recorded on the Pacific side of Panamá, the area which scored the highest number of species; six in Baja California; five in Acapulco; and five on the Pacific coast of Costa Rica. Three species were reported from the Pacific coasts of Nicaragua and one from Zorritos, Perú. Two species were found in the Galápagos Islands. In terms of species distribution *P. stenobrochis* shows the widest distribution (from México to Perú). *Pacifigorgia englemanni*, *P. exilis*, and *P. rutila* were only recorded for the Mexican Pacific. Based on this information, it is difficult to provide a reliable distribution map of this genus because the

species have been largely misidentified and only anecdotal reports about their abundance are available. Recent research on octocorals in Colombia and Baja California (Prahl et al. 1986, Sinsel-Duarte 1991) attempted to evaluate abundance and distribution, but the identification of the specimens was not clear and may be erroneous.

Seventeen species of *Pacifigorgia* are recognized as valid in this revision. Most of the taxonomic problems of these species were originated by inadequate descriptions in the old literature and also inappropriate manipulation of the type specimens in the museum's collections. With the exception of *P. agassizii* in which the original type could not be determined, in almost all case type specimens were available for examination. In the case of *P. douglasii* and *P. tabogae* although only permanent microscope slides of sclerites were available, they show clear differences with respect to the other described species to be recognized here as different species. *P. arenata* and *P. cribrum* are only characterized from the holotypes. These four species will be better characterized when fresh material is collected.

In establishing the identity of the nominal species of *Pacifigorgia* the combination of sclerite forms, patterns of branching, distribution of calyces, and color proved to be very reliable. The differences found between the species are tabulated in Table 1. *Pacifigorgia douglasii* and *P. tabogae* were not included in Table 1 because the holotype colonies were not found. The sclerite forms in most of the species made possible the definitive diagnoses. Capstans are present and abundant in almost all species, in diverse forms and sizes and show little difference between species. Hence, the difference between species becomes more evident based on the kind and abundance of spindles both acute and blunt rather than on capstans or in other more common sclerites. Consequently, the spindle sclerites should be considered of higher diagnostic value. The taxonomic importance of anthocodial

rods was also demonstrated here because their forms and colors are very specific. The use of the combination of the growth form of the colony, the sclerites, and the color of both allows accurate species identification, in spite of being considered characteristics highly influenced by the environment.

In many cases in the past, taxonomic confusion was also generated when only small specimens were available for identification (e.g., *P. adamsii* was mistaken with *P. irene*). For this reason, field observations and studies on gonad development are needed in order to determine the real form and size of the adult colony. Furthermore, genetic research would also help to determine intra- and interspecific relationships.

Recent collections made along the Pacific coast of Colombia (Prahl et al. 1986), Baja California (Sinsel-Duarte 1991), Costa Rica and Panamá reveal that many more species of *Pacifigorgia* have yet to be identified and recorded. In addition, many other specimens remain in museum cabinets awaiting study.

Further observations and the collection of fresh specimens from the original type localities would greatly enhance and complement the natural history of *Pacifigorgia* and lead to the better understanding of the taxonomy of this long neglected genus.

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